Research Report 1342

A Comparative Evaluation of M1 Tank Procedure Guides

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U. S. Army
Research Institute for the Behavioral and Social Sciences

September 1983

U. S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the Deputy Chief of Staff for Personnel

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Report 1342	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A COMPARATIVE EVALUATION OF M1 TANK PROCEDURE GUIDES		5. TYPE OF REPORT & PERIOD COVERED Research Report 6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Stephen L. Goldberg (ARI) and Charlotte H. Campbell (Human Resources Research Organization)		8. CONTRACT OR GRANT NUMBER(s) MDA-903-80-C-0223
9. PERFORMING ORGANIZATION NAME AND ADDRESS Human Resources Research Organization 1100 S. Washington St. Alexandria, VA 22314		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333		12. REPORT DATE September 1983 13. NUMBER OF PAGES 80
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) --		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

Technical quality of this research monitored by Stephen L. Goldberg.
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Job aids
M1 training
Procedural tasks

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this research was to evaluate M1 tank procedure guides developed by the Army Research Institute as aids in performance of procedural tasks. Twelve tasks, three for each of the four crew positions, were tested among 27 soldiers completing initial training at Fort Knox and 35 soldiers in M1 crews at Fort Hood. Soldiers used either the tank operator's manual (TM), the ARI procedure guides, or the TM checklist during task performance. Criterion measures included performance accuracy, measured as percent of steps passed and as GO or NO GO for the task as a whole, and time to (Continued)

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locate tasks in each job aid. Overall, performance using the procedure guides was as accurate as performance using the TM or the checklist. Time required to locate procedures in the procedure guides was less than was required by the TM and not different from the time required by the checklist. Soldiers' comments indicated that the procedure guides would be well received by M1 crewmembers. In order to be effective, use of the guides during task performance must be introduced in training as soon as task familiarity using the TM is achieved. Command emphasis in units would then have to require continued use of the guides in performance of non-combat procedural tasks.

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A Comparative Evaluation of M1 Tank Procedure Guides

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September 1983

Army Project Number
2Q263743A794

Armor Training and Performance

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FOREWORD

The Army Research Institute-Fort Knox has been working toward solution of training and performance problems that result from the Army's acquisition of sophisticated new weapon systems. The research has focused on the development and fielding of the M1 "Abrams" tank. Problems in personnel selection and assignment, individual and crew training, and training and performance in units are being investigated.

The M1 "Abrams" tank requires crewmen to perform a number of long procedural tasks to prepare for and secure after combat operations. The primary document for information on performance of these tasks is the tank operator's technical manual, TM 9-2350-255-10. The TM is to be used in training and as an aid in performing tasks in operational units. In operational testing of the M1, it was observed that many preoperational tasks were not being performed correctly and the TM was frequently not being used. Features of the TM, such as its large size, its being designed for novice performers, and its detailed task descriptions, could have contributed to these problems. Also, since there is only one TM per tank, the TM cannot be used by crewmen who must simultaneously power up their stations.

M1 procedure guides were designed to provide M1 crewmen with a job aid that they could use to perform the procedural tasks necessary to prepare for and secure from combat operations. The procedure guides present sufficient information for armor crewmen who have been previously trained to perform M1 tasks. The guides are grouped by duty station and use a flow chart format to handle decision making and recursive operations. In operational settings the procedure guides are each packaged in plastic binders to protect them from the dirt and grease of the tank work environment. Each page is inserted in a plastic cover to allow pages to be replaced as changes are made.

This report describes an evaluation of the M1 procedure guides against the operator's technical manual and a checklist produced by the tank's developer with respect to performance that results from their ease of use.

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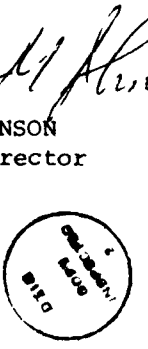

A COMPARATIVE EVALUATION OF M1 TANK PROCEDURE GUIDES

EXECUTIVE SUMMARY

Requirement:

Evaluate M1 tank procedure guides by comparison to the operator's technical manual (TM) and the TM checklist as aids in performance of noncombat procedural tasks.

Procedure:

Performance tests of 12 procedural tasks were administered to soldiers just completing initial M1 training at Fort Knox and to soldiers assigned to M1 tank crews at Fort Hood. Soldiers used the TM, the TM checklist, or the procedure guide as a job aid during the test of each task. Criterion measures included pass/fail ratings on task steps, GO/NO GO scores on each task as a whole, and time required by soldiers to locate tasks in each job aid.

Findings:

Performance using the procedure guides was as accurate as performance using the TM or the TM checklist. Time required to locate procedures in the guides was less than was required by the TM, and not different from the time required by the checklist. Soldiers' comments indicated that the physical construction of the guides, the arrangement and presentation of procedures, and the fact that the guides are crew station specific would make the guides acceptable to M1 crewmembers.

Utilization of Findings:

Results of this research effort indicate that further implementation of the procedure guides and long-term evaluation in M1 armor units should be effected. Use of the guides for task performance must be introduced in training as soon as task familiarity using the TM is achieved. Command emphasis in units would then have to be given to continued use of the guides as aids to performance of noncombat procedural tasks.

A COMPARATIVE EVALUATION OF M1 TANK PROCEDURE GUIDES

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A COMPARATIVE EVALUATION OF M1 TANK PROCEDURE GUIDES

INTRODUCTION

The M1 Abrams tank is a complex system that incorporates many technological improvements within its mechanical and fire control systems. Its laser rangefinder, lead angle sensor, thermal imagery sighting system, and ballistic computer are all designed to improve the tank's firing accuracy and to simplify its combat operation. The gunner has only to place his reticle on the target; there is no need to aim off to compensate for cant, target movement, or wind speed Range determination is fast and accurate. The crew can see targets through battlefield obscuration and can fire accurately on the move. But there is a price to be paid for the benefits of automated combat systems. Although the M1 tank is simpler to operate in combat than its predecessor, the M60A1 tank, the tasks required to power up, power down, and check operations of the M1's system are longer and more complex than comparable tasks on the M60A1 (Black & Kraemer, 1981). Training emphasis and appropriate documentation are required to ensure accurate performance of preoperation and postoperation tasks.

In the early stages of M1 fielding, there have been indications that procedural tasks are not being performed accurately. During the tank's Operational Test III (OT III), soldiers were tested on 11 procedural tasks after new equipment training (Maitland, Robinson, Butler, & Reynolds, 1981). None were performed correctly by at least 80% of the soldiers tested. The average rate of successful performance for these tasks was 44%.

The source of task documentation available during OT III, which was used in new equipment training, was the M1 tank operator's technical manual, TM 9-2350-255-10 (referred to as the TM). The TM is formatted using Skill Performance Aid (SPA) guidelines. Tasks are highly proceduralized. Each task description contains a verbal description of each task step and a series of illustrations. The TM has been carefully checked for accuracy, thoroughness, and ability to guide performance. It has all the characteristics of a very good reference for task information, but it seems to have some potential problems that could preclude its use as a job aid to guide task performance in operational settings.

Problems with the TM's size, organization, and availability could be limiting its effectiveness. The use of SPA formatting in describing tasks has resulted in a very large manual. The TM is about 3 inches thick and has over 800 pages, making it cumbersome to use in a tank work environment. Crewmen have trouble keeping it open on their laps. It is particularly unwieldy when one must turn back and forth between pages. The number of tasks that require performers to choose between alternative steps and therefore go from one point in the task description to another and then back is such that page flipping would be frequent.

The organization of the TM may also pose some problems. Tasks are organized according to crew position, in a roughly operational sequence, but are only listed in the index, not in the table of contents, making tasks often difficult to locate in the manual.

A major problem that hampers use of the TM in operational settings is that only one copy is issued per tank. Since each of the four crewmembers has preoperation and postoperation tasks to perform, either soldiers will have to take turns with the manual, or three soldiers will be doing tasks without the aid of the manual. Given the length and complexity of M1 procedural tasks, crewmen will have difficulty relying on their memories to produce adequate task performance (Goldberg, Drillings, & Dressel, 1981). That soldiers must try to rely on their memories and not on task documentation might be a contributing factor to their poor performance on procedural tasks at OT III.

A procedural checklist designated TM 9-2350-255-CL was developed along with the technical manual. The checklist was intended to supplement the TM as a quick reference for performing common tasks during normal and emergency operations. It is only 48 pages long and small enough to fit in the soldier's pocket. But it too has drawbacks. The checklist does not use the same organization as the TM, and it has no index. As a result, it may be difficult to find a task in the checklist after learning the task using the TM. The checklist is written at a much lower level of detail than the operator's manual, and in many instances warnings and cautions given in the TM are not present in the checklist. The checklist also greatly simplifies some tasks. For example, in describing a computer self-test, the checklist lists only the steps that would be followed when all systems are operating properly. It does not tell the soldier what steps would have to be taken if one or more systems failed the self-test, or even tell what the indicators of a failed self-test are. And no illustrations or table of contents are provided.

The impetus for the Army Research Institute's development of a set of job aids or procedure guidelines for the M1 tank was the poor performance on conducting procedures noted at OT III and the potential problems discussed above with the available documentation. The procedure guides build on recommendations by Dalzell and Harrison (1980) that a checklist should be provided for each tank crewmember. The ARI procedure guides provide a separate job aid for each crew station and cover the tasks at each station that are required to prepare the tank for combat and secure the tank after operations.

Many of the more complex M1 tasks were not readily adaptable to common checklist formats that simply list task steps due to the many decisions that crewmembers are required to make during performance of M1 tasks. To overcome this problem, an innovative algorithmic format was developed to incorporate these decisions. This format is similar to flow chart diagrams. At each decision point, the soldier is asked a question concerning the phase of operation, environmental conditions, status of lights or switches, etc. Based upon the soldier's answer, the appropriate succeeding steps are identified. Appendix A contains an example of the task formatting found in the procedure guides.

The guides were designed to include only information necessary to perform tasks. Symbols are used to indicate decision points, warnings, cautions, and where lights should be lit up. The TM task terminology is used and the performance steps are the same, in action and sequence, as those in the TM. Additionally, a table of contents is included. Illustrations of the instrument panels are provided in the back of each guide.

Like the checklist, the procedure guides were designed as supplements--not replacements--for the TM. If a situation that was not covered in the guide occurred, the soldier would be expected to refer back to the TM for a complete task description. Furthermore, initial task training would use the TM. Soldiers, after learning task terminology and location of equipment and acquiring a basic understanding of procedures, would begin to use the procedure guides for routine performance of tasks.

Thus three formats had been prepared to aid soldiers in performing procedural, noncombat tasks. Each format had been checked for accuracy. The TM contained the most information, including procedures for all four crew stations and complete troubleshooting guidance, but as a consequence was bulky and awkward to use. The checklist also contained procedures for all four stations, but was considerably condensed, possibly to the point of ineffectiveness.

The procedure guides were designed to overcome the perceived problems with the TM and TM checklist. They were formatted to accommodate the complexity of M1 tasks and covered only one crew station in each guide. The availability of the guides, their presentation style, and their completeness should provide crewmen with an accessible source of helpful information. The capability of the procedure guides to produce accurate task performance in comparison to that produced by either the TM or TM checklist will in part determine their relative worth as job performance aids.

OBJECTIVES

The objective of this research was to compare the effectiveness of the M1 procedure guides to the TM in aiding tank crewmen in performance of procedural tasks. Effectiveness of the TM checklist was also compared to the TM and procedure guides. Because the TM is the aid on which all M1 soldiers have trained and with which they are most familiar, performance of the tasks using the TM is the benchmark against which the value of the checklist and procedure guides is measured. Judgments on the effectiveness of the procedure guides rest in part on a comparison of soldier performance produced by the checklist, guides, and TM.

PROCEDURES

Soldiers at Fort Knox, KY, and Fort Hood, TX, performed M1 procedural tasks aided by either the tank operator's manual TM 9-2350-255-10, the M1 task checklist TM 9-2350-255-CL, or the ARI-developed M1 procedure guides. At Fort Knox, the 27 soldiers participating in the research were just completing M1 tank One Station Unit Training (OSUT). At Fort Hood, they were crewmembers of nine M1 crews (35 soldiers) in an operational M1 battalion. At Fort Knox, soldiers were tested only on driver, loader, and gunner tasks. At Fort Hood, drivers, loaders, and gunners likewise performed tasks from those three crew positions. In addition, tank commanders and gunners performed tank commander tasks. At each crew station, each soldier performed three tasks, each task with a different job aid. Job aids were rotated across soldiers and between tasks.

The data collected were time and accuracy measures of performance for a sample of M1 tasks. Time measures consisted of time to locate the procedure in the job aid and time to perform the task. Task performance accuracy ratings consisted of GO or NO GO scores on total task performance and for each step within a task. Prior to performing tasks using the job aids, soldiers worked through a short study guide to familiarize themselves with the checklist and procedure guides. Time measures on locating tasks in each job aid were then collected separately from time measures of task performance.

RESULTS

Performance Accuracy

Accuracy was first examined in terms of the percent of task steps performed correctly for each task using each job aid; test location was included as a factor for statistical control. Figure 1 presents this information for tasks at the four crew stations. Analysis of these results showed that the job aid used had a significant effect on performance accuracy for only one task, Perform Thermal Imagery Sight (TIS) Checkout. For this task the checklist produced poorer performance than both the TM and the procedure guides. There was no difference in performance of this task between soldiers using the TM and the procedure guide.

While most soldiers could complete most task steps correctly, the GO rate, or rate at which soldiers successfully completed tasks, was generally low. Figure 2 shows the percentage of soldiers who successfully completed each task as a function of the job aid they used. Gunner and tank commander tasks in particular had low rates of successful performance. The gunner tasks Perform Computer Self-Test and Perform TIS Checkout had one and two soldiers successfully perform them regardless of job aid used. Install Commander's Weapon was not performed correctly by any of the gunners or commanders, and Power Down Commander's Station was performed correctly by only three soldiers, all commanders. One loader task, Power Down Loader's Station, also had only one successful performance regardless of job aid. Of the remaining tasks, the job aid used made a difference in performance for two tasks, Power Up Driver's Station and Power Up Loader's Station. In both cases using the TM produced greater numbers of soldiers performing correctly.

Performance Time

Performance times were recorded for all tasks, but the data were not analyzed due to the generally low levels of acceptable performance of the tasks for all of the job aids. Given that most soldiers made errors on most tasks, there was no clear or consistent way to determine what the times included. Times might have been long because soldiers were thorough and methodical, or because they were very incompetent. Times might be short because soldiers were quick and proficient, or because they did not perform most of the task steps. With so few soldiers demonstrating equivalent acceptable performance, comparison of performance times is meaningless.

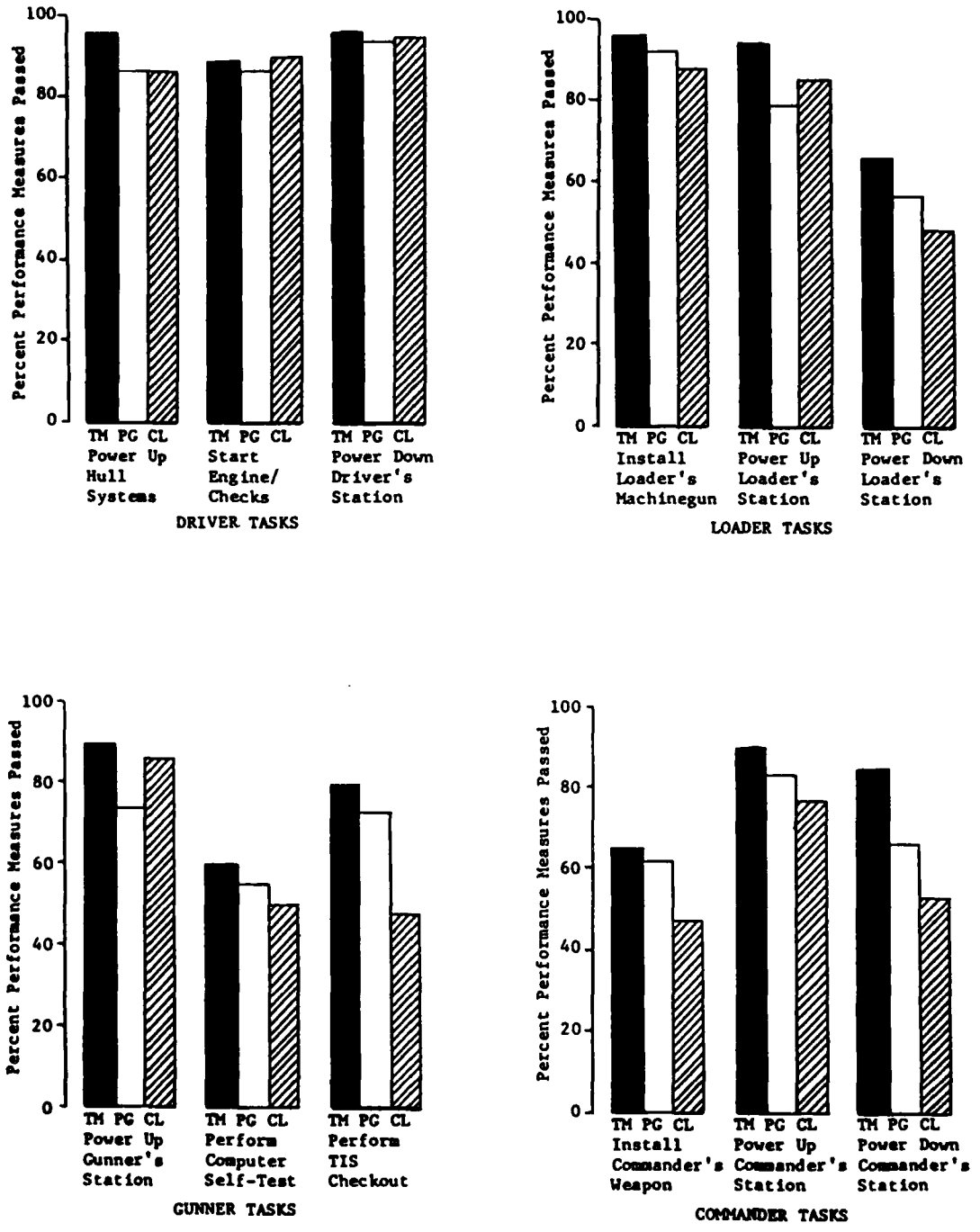

Figure 1. Mean accuracy (percent performance measures passed) for tasks using technical manual (TM), procedure guide (PG), or checklist (CL).

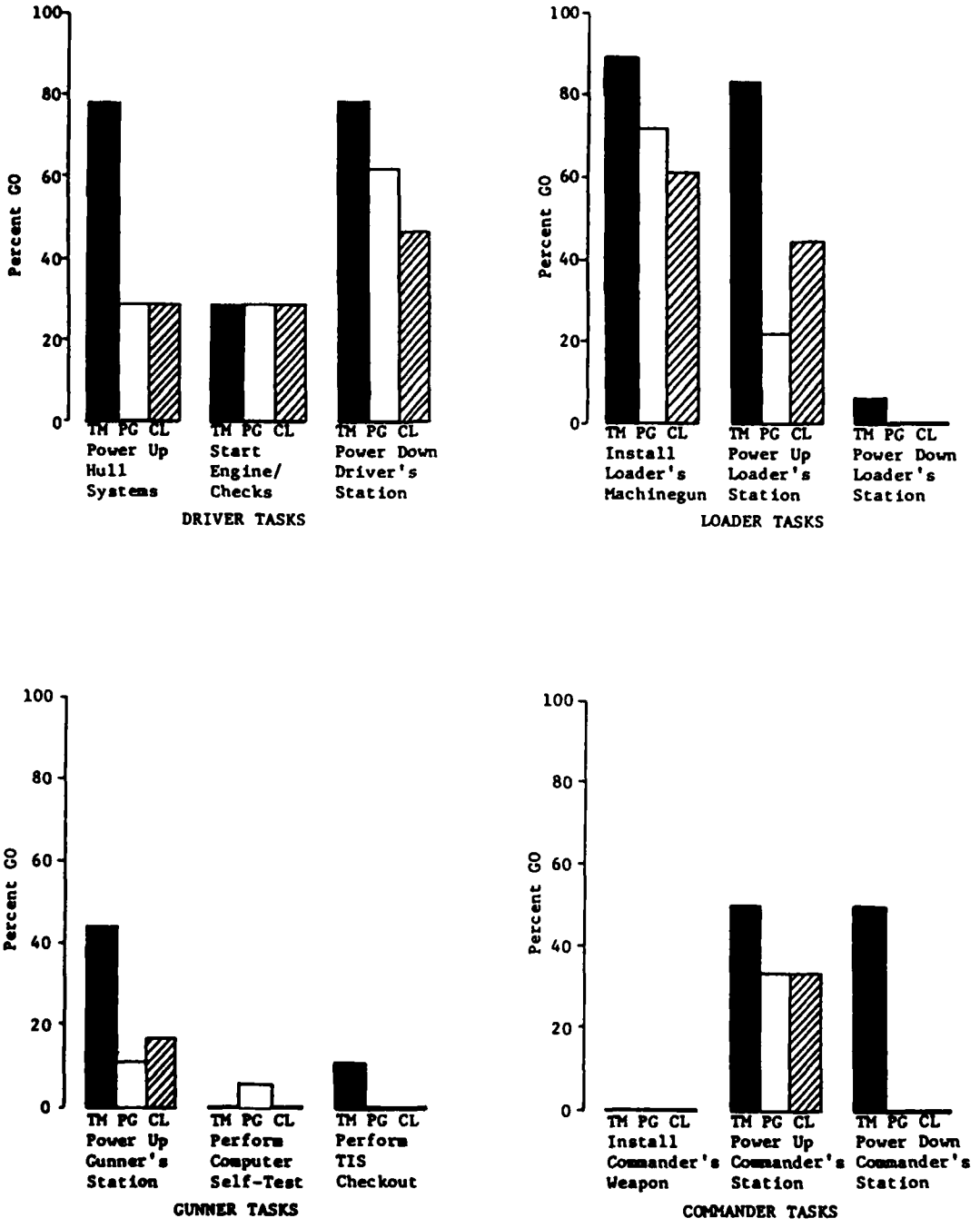

Figure 2. Percent of soldiers performing tasks correctly (GO) using technical manual (TM), procedure guide (PG), or checklist (CL).

Time to Locate Tasks in Job Aids

The time required to locate tasks in the three job aids is diagrammed in Figure 3. On all but two tasks (Power Up Driver's Station and Power Up Gunner's Station) the procedure guides elicited shorter times than the TM. In comparing the TM and the checklist, for nine tasks the TM required more time, for two tasks (Power Up Loader's Station and Perform Computer Self-Test) they required the same time, and for one task (Power Up Commander's Station) the checklist took longer. For only two tasks (Power Up Loader's Station and Power Up Commander's Station) were the procedure guides and checklist times different, both requiring more time in the checklist.

DISCUSSION

On the whole, the ARI M1 procedure guides produce task performance as accurate as that produced by either the TM or TM checklist. These performances, however, were alarmingly low, especially for the more complicated gunner tasks, regardless of aid. This suggests that soldiers did not have a mastery of the tasks at the time of testing and reinforces the argument for stressing use of job aids both in training and on the job.

There were some indications that soldiers were not totally comfortable with the symbols and abbreviations used in the procedure guides. For example, some soldiers did not recognize CCP as meaning computer control panel, or D as the symbol for drive on the transmission control, although both symbols are also used in the TM. And some soldiers did not know how to use the diamond symbol as a decision point to determine the steps to follow to adjust the commander's weapon. A more thorough introduction to the guides including hands on practice requiring understanding of the various symbols could improve performance with the guides.

Other errors made by soldiers are attributable to two sources: Soldiers were not proficient on the tasks at the time of testing, and the procedure guides and checklist do not contain sufficient detail for the nonperformer. For example, turning the domelight off and checking fuel levels are somewhat more complex, in both action and system response, than the bald statement of the steps indicates; accordingly, soldiers using the less detailed checklist and guides did not complete all the actions required.

An observation that came out of conducting the research is that soldiers were not performing tasks completely. A logical explanation may be that soldiers are not required by either their trainers or supervisors to pay close attention to detail and perform tasks by the book. With aids being unavailable, for the most part, in the field soldiers must do the best they can to get equipment operating. Under these conditions, steps that either protect or ensure the equipment is working accurately are likely to be left out. When soldiers are then put in a test situation such as they experienced here, it is possible that the same unrigorous approach is adopted even though they have use of a job aid. Poor performance demonstrated here on the TIS checkout task may in part explain why that system has failed as frequently as it has. In order to improve performance with the job aids, their use will have to be introduced early in training and performance accuracy stressed to a high degree.

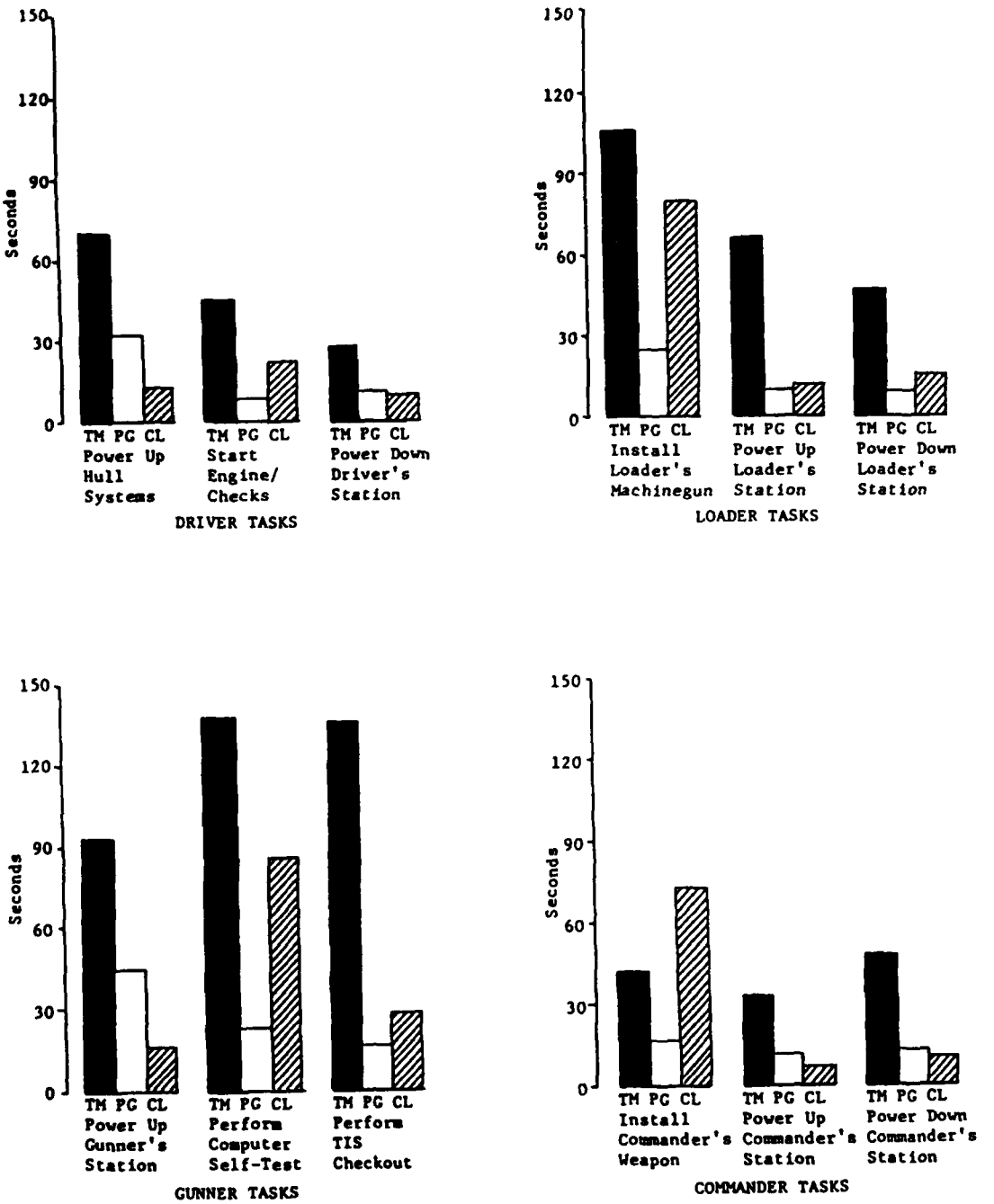

Figure 3. Time required to locate tasks in technical manual (TM), procedure guide (PG), or checklist (CL).

Past research has shown that the use of job aids in training can produce acceptable levels of proficiency in fewer trials (Scott, McDaniel, & Braby, 1982), and that crewmen are likely to use job aids if they perceive the aids as accurate and helpful (Maier & Kessler, 1975). During this research effort, soldiers commented that they liked many of the features of the procedure guides: that guides are crew station specific, are easy to use because the book lies flat, are water resistant and sturdy enough for constant use, and are easy to read and to locate information in. Soldiers reported that the checklist was too insubstantial to hold up under steady use. For both the checklist and the guides, soldiers lamented the lack of illustrations, but this may be due in part to their low levels of task familiarity.

In summary, the procedure guides produced performances that were no less accurate than performance using the TM or TM checklist. Initial reactions indicate that the procedure guides had a distinct appeal among soldiers. In order to be effective, the guides would have to be introduced in training shortly after tasks are taught with the TM. Command emphasis in units would then have to require continual use of the guides in performance on noncombat procedural tasks. Further testing of the procedure guides should take place after their implementation in operational units, to determine usage and user acceptance.

METHOD

Subjects

Data were collected at Fort Knox and Fort Hood. At Fort Knox the subjects were 27 soldiers who had just completed M1 One Station Unit Training (OSUT). At Fort Hood the subjects were 35 soldiers who were crewmembers of nine M1 tanks (one crew had only three crewmembers on the day of testing).

Task Selection

Three tasks were tested for each of the four tank crew positions. The criteria for selection of tasks were that the tasks be represented in all three job aids and that they all be testable within 2 hours in a motor pool (or similar) environment. The tasks selected are listed in Table 1. The technical manual (TM) for the M1 tank operator was used as the primary reference in developing hands-on tests of the tasks.

Table 1

Tasks Selected for Testing

Crew Position	Tasks
Driver	Power Up Hull Systems
	Start Engine and Make After Start Checks
	Shut Down Engine, Power Down and Secure Driver's Station
Loader	Install Loader's Machinegun
	Power Up Loader's Station
	Power Down Loader's Station
Gunner	Power Up Gunner's Station
	Perform Computer Self-Test
	Perform TIS Checkout
Tank Commander	Install Commander's Weapon
	Power Up Commander's Station
	Power Down Commander's Station

Performance Tests

The data to be collected consisted of time and accuracy measures of performance on each task. The time measures were additionally broken down

into two components: time to locate the procedure in a job aid and time to perform the task using the job aid. The test of time to locate tasks required soldiers to look up tasks in the three job aids and to tell the scorer when he found the task. Time to perform was obtained along with measures of performance accuracy during hands-on tests of each task.

Design

One version of the locate time test was administered to each of the 27 soldiers at Fort Knox and the 27 drivers, loaders, and gunners at Fort Hood. Each soldier had to locate the three tasks for the driver in one job aid, the three tasks for the loader in a second job aid, and the three tasks for the gunner in a third job aid. A slightly different version of the locate time test was administered to the nine commanders at Fort Hood. This version required them to look up all three commander tasks in each of the three job aids.

The performance tests for the nine driver, loader, and gunner tasks were administered to 27 soldiers at Fort Knox and 27 drivers, loaders, and gunners at Fort Hood. Each soldier used all three job aids at each crew position station, one for each of the three tasks at that crew position. The design was a series of balanced incomplete blocks with repeated measures, replicated for each of the three crew positions.

The three tank commander tasks were tested among only the nine gunners and nine tank commanders at Fort Hood. Each of the three tasks was tested with a different job aid for each soldier; the design was a simple repeated measures Latin square.

All three data collection designs are illustrated in Appendix B.

Procedure

At Fort Knox, soldiers were tested in groups of three. After an initial briefing which provided an overview of the testing and Privacy Act information, soldiers were given a short written study guide requiring them to use the procedure guide and the TM checklist to answer questions. The purpose was to give them an opportunity to examine and become somewhat familiar with the two job aids. The same familiarization was not provided for the TM, because soldiers had used the TM throughout training. The locate time test was then administered to the three soldiers.

Each soldier then went to one of the three crew position stations for the three performance tests for that crew position. Scorers recorded time and performance accuracy on the scoresheets as the soldier performed the tasks with the appropriate job aid.

At Fort Hood, soldiers reported for testing in groups of four (intact tank crews), and testing proceeded in a similar fashion, with the tank commander also completing the study guide and the locate time test. After the driver, loader, and gunner were tested, the gunner and the tank commander were tested on the tank commander tasks.

All data collection materials are presented in Appendix C.

RESULTS

Performance Accuracy

Accuracy data (percent of performance measures passed) on the driver, loader, and gunner tasks (see Table 2) were first analyzed by means of an analysis of variance (ANOVA). Test location and group (representing which of the three aid/task combinations by which a soldier was tested; see Table B.2) were between-subjects factors; and job aid, crew position, and task within crew position were within-subjects factors. The job aid by task interaction is partially confounded with group, and the job aid by task by location interaction is partially confounded with the location by group interaction. (The design is similar to Winer's (1971, p. 727) Latin square Plan 9, modified to accommodate the fourth variable, task, nested under one of the within-subjects variables, crew position.) The ANOVA summary table is contained in Appendix D. All main effects except group are significant, and all within-subjects interaction terms except for the job aid by task by location term are significant.

Interpretation of the ANOVA proved to be somewhat beyond the capabilities of normal reasoning; the small number of subjects (54) relative to the total degrees of freedom (485) gave rise to suspicions that the analysis was predicting error variance. Therefore the design was broken down into nine ANOVAs, each job with job aid as the factor of interest and test location as a between-subjects factor for statistical control.

The commander tasks were analyzed using a separate analysis of variance. Because the commander tasks were tested only at Fort Hood, using assigned gunners and tank commanders, the ANOVA had four factors: job aid, task, crewmember, and row (the job aid for each task). The ANOVA summary table is also included in Appendix D. The crewmember difference was significant, as was the task effect. For consistency of interpretation with the driver, loader, and gunner tasks, the ANOVA was separated into three separate ANOVAs, with crewmember (gunner or tank commander) as a statistical control variable.

To correct for the inflated experimental error rate due to the separate analyses, the protection levels for the driver, loader, and gunner tasks were set at .005 and .001, for effective values of approximately .05 and .01, respectively. The significance levels for the tank commander tasks were set at .017 and .003, corresponding to significance levels of about .05 and .01. In the discussions that follow, the effective levels (.05 or .01) are reported. The ANOVA is summarized in Table 3.

The only effects that influenced performance accuracy were job aids on Perform TIS Checkout and Power Down Commander's Station, and location in Power Down Loader's Station and Perform Computer Self-Test. Pairwise tests of differences between job aids on Perform TIS Checkout indicated that the checklist produced performance accuracy that was about 31% lower than performance with the TM and about 24% lower than with the procedure guides; the guide and TM did not differ. On Power Down Commander's Station, performance

Table 2

Means and Standard Deviations of Performance Accuracy (Percent Performance Measures Passed) on Driver, Loader, and Gunner Tasks by Test Location

TASK	JOB AID	FT. KNOX (N=9) Mean Percent	FT. KNOX (N=9) Standard Deviation	FT. HOOD (N=9) Mean Percent	FT. HOOD (N=9) Standard Deviation	TOTAL Mean Percent	TOTAL Standard Deviation
Power Up	TM	97.04	6.37	94.81	9.83	95.92	8.36
Hull	Proc. Guide	88.89	6.29	85.19	15.00	87.04	11.65
Systems	Checklist	91.11	8.31	82.96	14.44	87.04	12.47
Start	TM	92.75	4.58	85.51	14.05	89.13	11.06
Engine/	Proc. Guide	93.24	8.23	84.06	15.74	86.65	13.37
Checks	Checklist	89.86	7.94	89.37	11.06	89.61	9.63
Power Down	TM	94.44	9.56	98.89	3.14	96.67	7.46
Driver's	Proc. Guide	94.44	10.66	94.44	4.97	94.44	8.32
Station	Checklist	95.56	4.97	94.44	6.85	95.00	6.01
Install	TM	98.15	5.24	94.44	15.71	96.30	11.86
Loader's	Proc. Guide	92.59	15.93	90.74	11.42	91.67	13.89
Machinegun	Checklist	96.30	10.48	79.63	18.89	87.96	17.40
Power Up	TM	90.48	22.34	98.41	4.49	94.44	16.59
Loader's	Proc. Guide	85.71	13.47	71.43	24.28	78.57	20.89
Station	Checklist	84.13	12.50	85.71	26.94	84.92	21.02
Power Down	TM	71.11	15.95	60.00	23.57	65.56	20.88
Loader's	Proc. Guide	73.33	9.42	40.00	24.94	56.67	25.16
Station	Checklist	62.22	11.33	34.44	12.57	48.33	18.33
Power Up	TM	92.93	7.14	85.86	13.63	89.39	11.44
Gunner's	Proc. Guide	81.82	14.21	64.65	26.57	73.23	22.97
Station	Checklist	88.89	3.78	82.83	20.30	85.86	14.91
Perform	TM	63.64	18.68	56.57	23.77	60.10	21.67
Computer	Proc. Guide	74.75	20.00	34.34	17.55	54.55	27.61
Self-Test	Checklist	53.54	14.50	45.45	16.03	49.50	15.81
Perform	TM	78.70	10.48	80.56	18.52	79.63	15.08
TIS	Proc. Guide	74.07	13.51	71.60	19.89	72.84	17.05
Checkout	Checklist	41.05	17.70	55.86	24.27	48.46	22.49
		FT. HOOD GUNNERS (N=3)		FT. HOOD COMMANDERS (N=3)		TOTAL	
Install	TM	58.33	14.83	72.22	11.95	65.28	15.15
Commander's	Proc. Guide	47.22	16.08	76.39	10.39	61.81	19.90
Weapon	Checklist	51.39	16.78	41.67	5.89	46.83	13.48
Power Up	TM	86.67	9.43	93.33	9.43	90.00	10.00
Commander's	Proc. Guide	80.00	0.00	86.67	18.86	83.33	13.75
Station	Checklist	66.67	9.43	86.67	18.86	76.67	17.95
Power Down	TM	68.52	10.48	100.00	0.00	84.26	17.40
Commander's	Proc. Guide	61.11	12.00	70.37	13.86	65.74	13.77
Station	Checklist	48.15	9.44	57.41	10.48	52.78	11.00

Table 3

ANOVA Results (F and p) for Performance Accuracy Measured as Percent Performance Measures Passed

		TASK					
Source	df	Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station	Power Down Loader's Station
Job Aid	2	3.72	<1	<1	1.49	2.82	3.94
Location	1	2.33	3.33	<1	3.51	<1	23.09**[a]
Aid x Loc.	2	<1	<1	<1	1.39	1.45	1.78
Error	48						

		TASK		
Source	df	Power Up Gunner's Station	Perform Computer Self-Test	Perform TIS Checkout
Job Aid	2	4.41	1.29	13.34*[c]
Location	1	4.67	11.82*[b]	<1
Aid x Loc.	2	<1	4.13	1.00
Error	48			

		TASK		
Source	df	Install Cmdr's Weapon	Power Up Cmdr's Station	Power Down Cmdr's Station
Aid	2	2.28	1.09	9.31**[d]
Crewmember	1	2.13	2.27	7.75**[e]
Aid x Crm.	2	2.20	<1	1.53
Error	12			

*$p < .05$ (effective)
**$p < .01$ (effective)

[a] Knox-Hood=24.08(%), t (48)=4.81, $p < .01$

[b] Knox-Hood=18.52(%), t (48)=3.44, $p < .05$

[c] TM-Proc. Guide=6.79(%), t (48)=1.07, p not significant
TM-Checklist=31.17(%), t (48)=4.91, $p < .01$
Proc. Guide-Checklist=24.38(%), t (48)=3.84, $p < .01$

[d] TM-Proc. Guide=18.52(%), t (12)=2.53, p not significant
TM-Checklist=31.48(%), t (12)=4.29, $p < .05$
Proc. Guide-Checklist=12.96(%), t (12)=1.77, p not significant

using the TM was superior by about 31% to performance aided by the checklist, but no difference was detected between the procedure guides and either the TM or the checklist. On both tasks where location was significant, the Fort Knox soldiers performed better than the Fort Hood soldiers by about 24% on Power Down Loader's Station and by more than 18% on Perform Computer Self-Test.

It may be argued that the true test of a job aid is not whether its use produces more accurate performance, but whether it more often produces perfect performance. To test the point, each soldier's score on each task was converted to a GO, or 1, if all performance measures were passed, and otherwise to NO GO, or 0. (This also has the effect of reducing extraneous variance in percent scores due solely to the wording of the scoresheet, e.g., the decision to test checking switches by setting two switches to the incorrect position would produce two performance measures which test one step requiring the checking of perhaps seven or eight switches.) The numbers of GO and NO GO are reported in Table 4.

The GO/NO GO data on the driver, loader, and gunner tasks were first analyzed using the same design described earlier. The four-factor ANOVA (Appendix E) yielded significant main effects for job aid, for crew position, and for task within crew position, and a significant aid by task interaction, but the aid by task by location interaction was also significant, precluding a simple interpretation of the job aid and task results.

Likewise, the commander tasks were analyzed in one ANOVA, which resulted in significant crewmember, aid, and task as well as a crewmember by task interaction and a three-way interaction for aid, task, and crewmember. The GO/NO GO data were therefore analyzed by means of separate ANOVAs, using significance levels of .005 and .001 again for driver, loader, and gunner tasks and .017 and .003 for commander tasks. Five tasks (Power Down Loader's Station, Perform Computer Self-Test, Perform TIS Checkout, Install Commander's Weapon, and Power Down Commander's Station) were not analyzed because so few scores of GO were recorded (one for each of the first two tasks; two for the TIS tasks; none for Install Commander's Weapon; and three, all for commanders using the TM, on Power Down Commander's Station). The ANOVA F and p values are reported in Table 5.

The tests on these analyses indicate that the job aids had different effects on GO/NO GO performance for only two tasks: Power Up Hull Systems and Power Up Loader's Station. On the first of these, users of the TM outstripped both procedure guide and checklist users; nearly three times as many TM users scored GO as did users of either of the other aids. On the second task, the difference was due to performance, with the TM compared to the procedure guide; almost four times as many soldiers using the TM scored GO.

Performance Accuracy Among Experienced and Inexperienced Crewmembers

Because the amount of experience as driver, loader, and gunner varied widely among M1 crewmembers at Fort Hood (see Table 6), a final set of analyses compared performance accuracy (percent of measures passed) of soldiers with no experience or less than 1 month experience assigned to a crew position with performance of soldiers who had been assigned to the position

Table 4

Numbers of Soldiers Scoring GO[a] on Tasks by Job Aid and Location or Crewmember

TASK	JOB AID	FT. KNOX	FT. HOOD	TOTAL
Power Up Hull Systems	TM Proc.Guide Checklist	7 1 3	7 4 2	14 5 5
Start Engine/ Checks	TM Proc.Guide Checklist	2 4 2	3 1 3	5 5 5
Power Down Driver's Station	TM Proc.Guide Checklist	6 7 5	8 4 5	14 11 10
Install Loader's Machinegun	TM Proc.Guide Checklist	8 7 8	8 6 3	16 13 11
Power Up Loader's Station	TM Proc.Guide Checklist	7 3 2	8 1 6	15 4 8
Power Down Loader's Station	TM Proc.Guide Checklist	1 0 0	0 0 0	1 0 0
Power Up Gunnner's Station	TM Proc.Guide Checklist	4 1 0	4 1 3	8 2 3
Perform Computer *Self-Test*	TM Proc.Guide Checklist	0 1 0	0 0 0	0 1 0
Perform TIS Checkout	TM Proc.Guide Checklist	0 0 0	2 0 0	2 0 0

		GUNNERS	FT. HOOD COMMANDERS	TOTAL
Install Commander's Weapon	TM Proc.Guide Checklist	0 0 0	0 0 0	0 0 0
Power Up Commander's Station	TM Proc.Guide Checklist	1 0 0	2 2 2	3 2 2
Power Down Commander's Station	TM Proc.Guide Checklist	0 0 0	3 0 0	3 0 0

[a]Each task x aid x location cell has nine soldiers; each task x aid x crewmember cell has three soldiers.

Table 5

ANOVA Results (F and p) for Performance Accuracy Measured as GO/NO GO

		TASK				
Source	df	Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station
Job Aid	2	7.36*[a]	<1	1.04	2.05	9.30**[b]
Location	1	<1	<1	<1	3.89	<1
Aid x Loc.	2	1.18	1.39	1.52	2.27	2.70
Error	48					

		TASK			TASK
Source	df	Power Up Gunner's Station	Source	df	Power Up Cmdr's Station
Job Aid	2	3.35	Job Aid	2	<1
Location	1	<1	Crewmember	1	6.25
Aid x Loc.	2	<1	Aid x Crm.	2	<1
Error	48		Error	12	

*p <.05 (effective)
**p <.01 (effective)

[a] TM-Proc. Guide=.500, t (48)=3.32, p < .05.
TM-Checklist=.500, t (48)=3.32, p < .05.
Proc. Guide-Checklist=0.00

[b] TM-Proc. Guide=.500, t (48)=4.26, p < .01
TM-Checklist=.389, t (48)=2.713, p not significant
Proc. Guide-Checklist=-.222, t (48)=1.55, p not significant

Table 6

Months of Experience Assigned to Each Crew Position Among Soldiers at Fort Hood

		Driver	Loader	Gunner
No Experience (< 1 month)	N	13	13	16
Experienced	N	12	14	8
(≥ 1 month)	Mean (Months)	6.6	7.5	5.9
	S.D. (Months)	4.2	5.9	4.3

a month or longer. Performance summaries are in Table 7. In the nine separate analyses (summarized in Table 8), with job aid and experience as factors, no differences were significant.

Table 7

Means and Standard Deviations of Performance Accuracy (Percent Performance Measures Passed) by Experienced and Not Experienced Soldiers

		EXPERIENCED			NOT EXPERIENCED		
TASK	JOB AID	Mean	Standard Deviation	N	Mean	Standard Deviation	N
Power Up	TM	90.67	11.62	5	100.00	0.00	4
Hull	Proc. Guide	89.33	15.55	5	80.00	12.47	4
Systems	Checklist	73.34	6.66	2	86.67	13.98	5
Start	TM	89.13	6.52	2	78.26	14.02	5
Engine/	Proc. Guide	77.39	17.91	5	92.39	5.65	4
Checks	Checklist	90.43	7.48	5	88.05	14.21	4
Power Down	TM	100.00	0.00	5	97.50	4.33	4
Driver's	Proc. Guide	95.00	5.00	2	96.00	4.90	5
Station	Checklist	94.00	8.00	5	95.00	5.00	4
Install	TM	90.00	20.00	5	100.00	0.00	2
Loader's	Proc. Guide	93.33	8.17	5	87.50	13.82	4
Machinegun	Checklist	79.16	18.16	2	80.00	19.44	7
Power Up	TM	100.00	0.00	2	97.14	5.72	7
Loader's	Proc. Guide	68.57	20.99	5	57.14	28.57	2
Station	Checklist	82.86	34.28	5	89.28	11.84	4
Power Down	TM	70.00	17.89	5	47.50	23.85	4
Loader's	Proc. Guide	30.00	15.81	2	48.00	27.86	7
Station	Checklist	42.00	7.48	5	30.00	10.00	2
Power Up	TM	90.91	9.09	2	84.42	14.34	7
Gunner's	Proc. Guide	86.36	4.55	3	49.09	24.12	4
Station	Checklist	84.09	27.56	4	81.82	11.50	5
Perform	TM	65.91	29.72	4	49.09	13.61	5
Computer	Proc. Guide	50.00	4.55	2	29.87	17.32	7
Self-Test	Checklist	50.00	4.55	3	36.36	15.21	4
Perform	TM	93.06	4.17	3	67.78	15.27	4
TIS	Proc. Guide	65.97	23.84	4	76.11	14.55	5
Checkout	Checklist	43.06	12.50	2	59.53	25.54	7

Note.- Soldiers are defined as experienced with respect to a crew position if they are or have been assigned to the position for one month or longer.

Performance Time

Performance times were recorded for all tasks but were not analyzed because there was no clear or consistent way to determine what the times implied. A soldier was permitted as much time as he wanted to perform the task and was prompted only when he asked for help, when he was about to do something that presented an immediate danger to people or equipment, or when he stalled. Thus the times might be long because the soldier was thorough and

methodical or because he was very incompetent; times might be short because the soldier was quick and proficient or because the did not perform most of the task steps. One approach might have been to analyze the performance times for all cases of perfect task performance, but there were so few such cases that no analysis was done.

Table 8

ANOVA Summary (F and p values) of Experienced and Not Experienced Soldiers on Performance Accuracy (Percent Performance Measures Passed) for Driver, Loader, and Gunner Tasks

		TASK					
Source	df	Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station	Power Down Loader's Station
Job Aid	2	2.46	<1	1.06	1.42	4.48	2.36
Experience	1	<1	<1	<1	<1	<1	<1
Aid x Exp.	2	1.46	1.59	<1	<1	<1	1.70
Error	19						

		TASK		
Source	df	Power Up Gunner's Station	Perform Computer Self-Test	Perform TIS Checkout
Job Aid	2	1.67	1.42	2.99
Experience	1	2.72	3.48	<1
Aid x Exp.	2	1.41	<1	1.71
Error	19			

Locate Time Tests

The locate time test results were recorded in seconds. In cases where soldiers could not (or would not) find the task, the missing value was replaced by a score equal to the highest obtained score for the condition (job aid by task) plus one-half of the standard deviation for obtained scores in the condition. This penalty score was used on the assumption that the soldier could have found the procedure if he had continued searching and that he would have required more time than all soldiers who did find the procedure. An analysis of variance was performed to determine whether missing scores were randomly distributed across tasks, job aids, and locations or crewmembers, or whether they were associated with particular aids or tasks; none of the factors or interactions was significant.

The means, standard deviations, and number tested for the locate time test are presented in Table 9. Twelve ANOVAs were performed. For each of the driver, loader, and gunner tasks, job aid was the factor of interest, and test location was a factor for statistical control only. The three

Table 9

Means, Standard Deviations, and Numbers Tested on Locate Time Test by Test Location

TASK	JOB AID	FT. KNOX (N=9) Mean (Seconds)	FT. KNOX (N=9) Standard Deviation	FT. HOOD (N=9) Mean (Seconds)	FT. HOOD (N=9) Standard Deviation	TOTAL Mean (Seconds)	TOTAL Standard Deviation
Power Up	TM	64.88	70.44[a]	77.89	58.01	71.38	64.85
Hull	Proc. Guide	19.11	8.28	45.64	51.99[e]	32.38	39.52
Systems	Checklist	11.44	8.52	13.67	14.73	12.56	12.08
Start	TM	36.67	29.56	52.78	29.31	44.72	30.52
Engine/	Proc. Guide	8.11	4.01	8.89	4.73	8.50	4.40
Checks	Checklist	21.11	31.39	23.89	20.11	22.50	26.40
Power Down	TM	27.89	26.59	27.44	13.20	27.66	20.99
Driver's	Proc. Guide	12.33	4.39	10.33	8.79	11.33	7.02
Station	Checklist	8.78	9.26	11.67	11.87	10.22	10.74
Install	TM	83.89	82.27	127.88	58.14[f]	105.88	74.55
Loader's	Proc. Guide	30.00	22.47[b]	15.33	5.59	22.66	17.94
Machinegun	Checklist	97.82	45.67[b]	60.18	22.29[g]	79.00	40.56
Power Up	TM	56.11	28.91	75.68	46.25[h]	65.90	39.79
Loader's	Proc. Guide	10.89	5.60	10.11	2.57	10.50	4.37
Station	Checklist	10.89	5.75	13.11	6.58	12.00	6.28
Power Down	TM	36.00	25.42	57.89	40.21	46.94	35.37
Loader's	Proc. Guide	9.89	9.52	9.00	2.91	9.44	7.05
Station	Checklist	11.78	6.94	18.11	9.03	14.94	8.65
Power Up	TM	75.67	58.73	111.00	100.53	93.33	84.20
Gunner's	Proc. Guide	43.89	56.13	48.15	25.91[i]	46.02	43.77
Station	Checklist	15.56	8.11	15.67	7.87	15.61	7.99
Perform	TM	72.22	50.55	201.46	193.13[j]	136.84	155.25
Computer	Proc. Guide	22.44	22.67	22.22	13.03	22.33	18.49
Self-Test	Checklist	112.51	89.85[c]	57.22	32.53	84.86	73.01
Perform	TM	134.54	147.90[d]	131.02	84.25[k]	132.78	120.37
TIS	Proc. Guide	17.67	25.69	13.56	6.58	15.61	18.86
Checkout	Checklist	20.33	18.10	34.78	38.24	27.56	30.78
Install	TM			41.00	11.56		
Commander's	Proc. Guide			15.89	7.12		
Weapon	Checklist			74.26	38.60[l]		
Power Up	TM	(NA)		33.00	20.33	(NA)	
Commander's	Proc. Guide			10.00	3.40		
Station	Checklist			6.78	2.48		
Power Down	TM			48.00	37.96		
Commander's	Proc. Guide			10.78	1.87		
Station	Checklist			9.11	5.42		

Note 1.- Locate Times Test for Tank Commander Tasks not administered at Ft. Knox.
Note 2.- Missing times were replaced by a penalty score equal to the maximum score for the task, aid, and location plus one-half the standard deviation for the task, aid, and location. Scores were added in cells with superscripts as follows:

a. One score of 196.97
b. Three scores of 132.89
c. One score of 240.42
d. One score of 422.84
e. One score of 147.82
f. One score of 207.94
g. One score of 98.15
h. One score of 150.16
i. One score of 89.36
j. Two scores of 487.06
k. Two scores of 226.10
l. One score of 132.34

commander task analyses were one-way ANOVAs. As before, protection levels were set a priori at .005 and .001 for the nine driver, loader, and gunner tasks, and at .017 and .003 for commander tasks, for the effective rates of about .05 and .01, respectively. The ANOVA F and p values are in Table 10.

Table 10

ANOVA Results (F and p) for Locate Time Tests

		TASK					
Source	df	Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station	Power Down Loader's Station
Job Aid	2	8.23**	11.40**	8.56**	16.30**	37.50**	13.84**
Location	1	1.34	1.10	<1	<1	1.38	2.10
Aid x Loc.	2	<1	<1	<1	4.00	1.14	1.14
Error	48						

		TASK				TASK		
Source	df	Power Up Gunner's Station	Perform Computer Self Test	Perform TIS Checkout	df	Install Cmdr's Weapon	Power Up Cmdr's Station	Power Down Cmdr's Station
Job Aid	2	9.45**	6.79**	13.36**	2	11.82**	13.46**	8.86**
Location	1	<1	<1	<1	-	-	-	-
Aid x Loc.	2	<1	4.63	<1	-	-	-	-
Error	48				16			

*p <.05 (effective)
**p <.01 (effective)

For every analysis, the job aid's main effect was significant; location and the interaction were not. Pairwise tests of the differences between job aids revealed relatively consistent relationships among the three formats (Table 11). On nine of the 12 tasks, locating a procedure in the TM took significantly longer than locating it in the procedure guides; likewise on nine tasks the TM required more time than the checklist. The guides and checklist produced different times on only two of the tasks; in both cases the procedure guide was associated with shorter locating times.

Table 11

Pairwise Differences in Locate Times Among Job Aids by Task

	TASK					
Comparison	Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station	Power Down Loader's Station
TM-Proc.Guide	39.01	36.22	16.33	83.22	55.40	37.50
t	2.64	4.74**	3.46*	5.60**	7.60**	4.87**
TM-Checklist	58.83	22.22	17.44	26.88	53.90	32.00
t	3.99**	2.90*	3.70**	1.81	7.40**	4.16**
P'Guide-C'List	19.82	-14.00	1.11	-56.34	-1.50	5.50
t	1.34	-1.83	.23	3.79**	-.21	-.71

	TASK					
Comparison	Power Up Gunner's Station	Perform Computer Self-Test	Perform TIS Checkout	Install Cmdr's Weapon	Power Up Cmdr's Station	Power Down Cmdr's Station
TM-Proc.Guide	47.32	114.51	117.17	25.11	23.00	37.22
t	2.63	3.68**	4.74**	2.08	4.17**	3.56**
TM-Checklist	77.72	51.98	105.22	-33.26	26.22	38.89
t	4.31**	1.67	4.26**	-2.76	4.76**	3.72**
P'Guide-C'List	30.40	-62.54	-11.95	-58.37	3.22	1.67
t	1.69	-2.01	-.48	-4.85**	.58	.16

*$p < .05$ (effective)
**$p < .01$ (effective)

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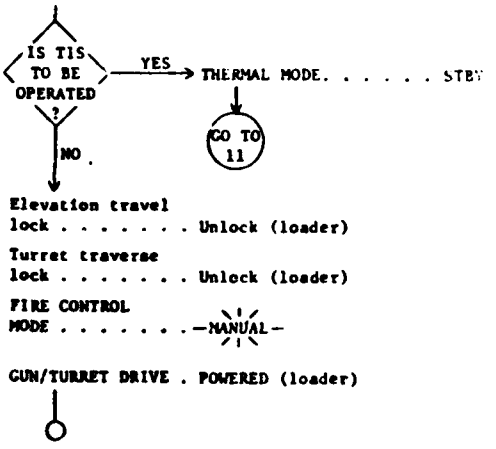
APPENDIX A

Sample Page from Procedure Guide: Power Up Gunner's Station

POWER UP STATION

IF LOUD, HIGH-PITCHED SQUEALING NOISE IS HEARD, OR IF HYDRAULIC PRESSURE DROPS SUDDENLY TO BELOW 500 PSI, SHUT OFF TURRET POWER AND SHUT DOWN ENGINE.

1. Turret power . . . Assure ON
2. Electrical system gage. . . . Assure minimum 18 volts
3. Engine or AUX HYD PWR. . . . Running or ON (TC)
4. PANEL LIGHTS TEST button. . . . Press — All lights on GPS upper and lower panels and TIS panel on
5. PANEL LIGHTS . . . Adjust
6. Hydraulic pressure gage. . . 1500-1700 PSI
7. CCP power. . . . . ON
8. CCP TEST button. . Press/check lights
9. CCP cover. . . . . Close/latch



11. Elevation travel lock . . . . . Unlock (loader)
12. Turret traverse lock . . . . . Unlock (loader)
13. FIRE CONTROL MODE . . . . . MANUAL
14. GUN/TURRET DRIVE . POWERED (loader)

APPENDIX B

Experimental Design Diagrams

Table B.1

Job Aid Used for Locate Time Tests

Soldier	Assigned Crew Position[a]	Tasks Order	Job Aid Used For DVR	LDR	GNR
1,10,19	Driver	DVR-LDR-GNR			
2,11,20	Loader	LDR-GNR-DVR	TM	PG	CL
3,12,21	Gunner	GNR-DVR-LDR			
4,13,22	Driver	DVR-LDR-GNR			
5,14,23	Loader	LDR-GNR-DVR	PG	CL	TM
6,15,24	Gunner	GNR-DVR-LDR			
7,16,25	Driver	DVR-LDR-GNR			
8,17,26	Loader	LDR-GNR-DVR	CL	TM	PG
9,18,27	Gunner	GNR-DVR-LDR			
28-35[b]	Commander		TM	PG	CL

[a] Ft. Hood only; Ft. Knox soldiers did not have assigned crew positions.
[b] Ft. Hood only; commander tasks were not tested at Ft. Knox.

Table B.2
Experimental Design for
Driver, Loader, and Gunner Performance Tests

Soldier	Assigned Crew Position	Station Order	Job Aid Used For: Power Up Hull Systems	Start Engine/ Checks	Power Down Driver's Station	Install Loader's Mach'gun	Power Up Loader's Station	Power Down Loader's Station	Power Up Gunner's Station	Perform Computer Self-Test	Perform TIS Checkout
1,10,19	Driver	DVR-LDR-GNR									
2,11,20	Loader	LDR-GNR-DVR	TM	P'Guide	C'List	P'Guide	C'List	TM	C'List	TM	P'Guide
3,12,21	Gunner	GNR-DVR-LDR									
4,13,22	Driver	DVR-LDR-GNR									
5,14,23	Loader	LDR-GNR-DVR	P'Guide	C'List	TM	C'List	TM	P'Guide	TM	P'Guide	C'List
6,15,24	Gunner	GNR-DVR-LDR									
7,16,25	Driver	DVR-LDR-GNR									
8,17,26	Loader	LDR-GNR-DVR	C'List	TM	P'Guide	TM	P'Guide	C'List	P'Guide	C'List	TM
9,18,27	Gunner	GNR-DVR-LDR									

Note.-The three major groupings in the design shown are represented in the analysis by the Groups factor.

Table B.3
Experimental Design for
Tank Commander Performance Tests
(Ft. Hood)

Soldier	Assigned Crew Position	Job Aid Used For: Install Cmdr's Weapon	Power Up Cmdr's Station	Power Down Cmdr's Station
3,18,24 28,31,34	Gunner Commander	C'List	TM	P'Guide
6,12,27 29,32,35	Gunner Commander	TM	P'Guide	C'List
9,15,21 30,33,36	Gunner Commander	P'Guide	C'List	TM

Note.-The three groupings shown in the design are represented in the analyses by the Groups factor.

APPENDIX C

Data Collection Materials

GENERAL INSTRUCTIONS FOR ADMINISTERING AND SCORING JOB AID TESTS

1. The purpose of this study is to measure speed and accuracy of soldiers as they perform various M1 tank tasks using one of three job aids:
   - TM 9-2350-255-10, Operator's Manual for M1 Tank
   - TM 8-2350-255-CL, M1 Tank Crew Checklist
   - Procedure Guides (Driver, Loader, Gunner, Commander) for M1 Tank

2. The equipment and site requirements for testing are listed in the Consolidated Equipment and Site Requirements List (para 6 below). Personnel required include three trained scorers, one tank commander, and one test site supervisor (TSS).

3. Test materials include:
   a. General Instructions for Administering and Scoring Job Aid Tests. Includes handling of soldiers and rules for scoring tests.
   b. Job Aids Tests Briefing. To be read to soldiers before tests are administered, and to provide familiarization with job aids.
   c. Driver, Loader and Gunner Study Guides. To familiarize soldiers with the Procedure Guide and TM Checklist formats.
   d. Job Aids Locate Time Tests. To measure times to find procedures in each job aid.
   e. Requirements for Job Aids Testing - Driver's Station, Loader's Station, Gunner's Station, Tank Commander's Station. Includes station equipment, personnel, and site requirements.
   f. Station Setup - Driver's Station, Loader's Station, Gunner's Station, Tank Commander's Station. Includes test site preparation before each test session, station restoration before each soldier, and additional station maintenance instructions as needed.
   g. Scoresheets - Driver's Station, Loader's Station, Gunner's Station, Tank Commander's Station (3 each). Contains soldier identification, instructions to soldiers, performance measures for each task, and special scoring instructions for performance measures as needed.

4. Handling of Soldiers (TSS Instruction)

NOTE: Tests may be conducted either with a full crew of four soldiers, or with only three soldiers. In the latter case, tank commander tasks will not be tested. Unless otherwise noted, instructions below apply in both situations.

   a. Read Job Aids Tests Briefing to soldiers.
   b. Give each soldier a Study Guide, the corresponding Procedure Guide, and a TM Checklist. As the soldier completes the Study Guide, a scorer should check his answers, and correct them, showing him the correct answers in the job aid as necessary.
   c. Administer Locate Times Tests, with one scorer testing each soldier.
   d. With three soldiers, send one soldier to each tank. With four soldiers, keep the tank commander in the waiting area, and test the other three soldiers on the driver, loader, and gunner's stations. When the three have completed testing on all three stations, have them wait in the waiting area, and test the tank commander (and gunner, if planned) on the tank commander tasks.

e. When three soldiers are being tested, they should rotate from driver's to loader's station, from loader's to gunner's station, from gunner's to driver's station. If the soldiers have assigned crew positions, they should begin at the station for their position. If the gunner and TC are to be tested on TC tasks, the gunner should be tested on these tasks at the loader's station (his last station) and the TC should be tested at the gunner's station.

5. Rules for Conducting and Scoring Job Aids Tests (Scorer Instructions)
   a. Prepare the station for testing before the soldier arrives.
   b. Position yourself and the soldier as directed on the scoresheet.
   c. Read the instructions to the soldier. Hand the appropriate job aid to him, opened to the correct page, just before you tell him to begin. (The job aid to be used will be circled on the scoresheet.)
   d. If the soldier has a question, read the instructions to him again. If he still does not understand, say "Do the best you can."
   e. Start timing the task as you say "Begin." Stop timing when the last PM is completed. (NOTE: If PM are done out of scoresheet sequence, the last PM performed may not be the last PM listed.)
   f. Mark a PM "Yes" if the soldier does the action. Mark "No" if he omits a PM (but see para 5.k below) or does it incorrectly. Mark "V" or "VP" as described in para 5.k(4) below.
   g. Where an asterisk (*) appears on the scoresheet, the PM must be done before the next test starts. If the soldier completes a test and has not done a PM so marked, stop timing and either do it for him (preferred) or tell him to do it (if necessary).
   h. Notes are given on the scoresheets where PM must be performed before the test continues. *These are important safety measures and must be followed!*
   i. On PM where the soldier is to check a switch or control in another crewmember's station, score "Yes" if the soldier tells you he would check, or would ask the other crewmember, or if he asks you or if he does it himself.
   j. If you don't see the soldier perform a PM, and you can't tell whether he did it, don't guess. Mark the scoresheet NS (not scored).
   k. The scorer will prompt if the soldier is unable to proceed with the task, as follows:
      (1) A prompt should be given only when the soldier is unable to proceed, or if his error can cause damage or injury.
      (2) The first prompt for any PM will be verbal "You must [read PM to the soldier]."
      (3) If the soldier is unable to perform the PM after a verbal prompt, perform the step for him and tell him to continue.
      (4) Mark the scoresheet with a V (verbal) or VP (verbal and perform) for all PM which were prompted.
      (5) Continue timing.
   l. If a malfunction occurs during a test:
      (1) Stop the test, record the elasped time and the PM where the test was stopped.
      (2) Have the soldier leave the tank.
      (3) Have the TC check the tank and correct if possible.
      (4) Note the malfunction on the scoresheet; note whether or not it was the soldier's fault.
      (5) If malfunction is corrected, restore station for the test, and have soldier repeat entire task; begin scoring and timing where test was stopped on first attempt.

(6) If the malfunction can't be corrected, but part of the task (beyond the involved PM) can be tested, do so. Be sure to indicate which PM could not be scored.

m. Anything that happens that is not provided for in the preceeding guidance, describe on the scoresheet. Be specific.

6. Consolidated Equipment and Site Requirements List:

a. Equipment

(1) 3 fully operational M1 tanks.
(2) 1 extractor tool.
(3) 1 dummy round.
(4) 1 wooden block for tripping extractors.
(5) 1 complete antenna (AS 1729).
(6) 1 set of chock blocks.
(7) 1 loader's machinegun.
(8) 2 CVC with complete cables (1 for commander testing).
(9) 1 commander's machinegun (for commander testing only).
(10) 1 adjustable wrench in tool bag (for commander testing only).
(11) 4 sets job aids
(12) 1 set scoresheets per station per soldier.

b. Site

(1) The Loader's Station (and Tank Commander's Station) tank may be located indoors or outdoors.
(2) The Driver's Station tank must be outdoors, with clearance in back and front to prevent injury or damage when tank is started.
(3) The Gunner's Station tank must be outdoors with room for full safe turret movememt.
(4) An object such as a boresight panel must be located at least 1000 meters from the Gunner's Station tank with line of sight.

JOB AIDS TESTS

BRIEFING

Read the following to the Soldiers:

"This research falls under the provisions of the Privacy Act. I have copies of the Privacy Statement if anyone wants to read it.

"Today you will be helping us with a test of three M1 job aids: the TM, the TM Checklist, and Procedure Guides for each M1 crew position. We are trying to determine which job aid works best with which tasks. To do this, we will ask each of you to do three tasks at the driver's station, the loader's station, and the gunner's station. [We will have the TC do three tank commander tasks also.] We will be scoring and timing gunner and each task, but remember: we're testing the job aids, not you.

"We know that all of you are familiar with the TM, and some of you may have worked with the TM Checklist. In order to give all of you a chance to examine the TM Checklist and the Procedure Guides, we have prepared some brief study guides. Please note: these are not tests! Please use the TM Checklist and the Procedure Guides to fill out these study guides now."

DRIVER

STUDY GUIDE

Use the TM CHECKLIST for these questions

What is the Page Letter Code for Driver Checks During Normal Operations?_____

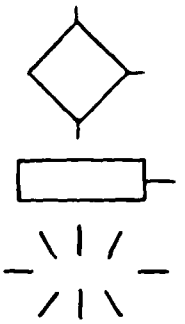
On what page are the steps for Place Tank in Motion?_____

On what page are the steps for emergency service of the air cleaner?_____

Turn to page D-8. After you close and lock the driver's hatch, what should you do next?_____

Use the DRIVER PROCEDURE GUIDE for these questions

Write the letter of the right meaning by each symbol.



Meaning

_____

_____

_____

A. More information or a caution or warning.

B. Knob or switch position and light.

C. Question.

On what page are the steps for Before Operations PMCS?_____

On what page is the picture of the Driver's Alert Panel?_____

Turn to page 20. If the tank is operating under arctic conditions, what should you do after removing the hose breakaway socket?_____

Turn to page 27. What should happen when the heater is turned on?

_____

LOADER

STUDY GUIDE

Use the TM Checklist for these questions:

What is the Page Letter Code for Loader Checks During Normal Operations?_____

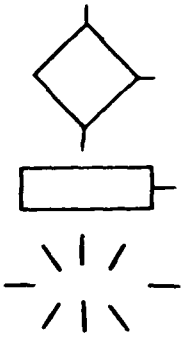
On what page are the steps for Loader's Firing Operations?_____

On what page are the steps for emergency service of the air cleaner?_____

Turn to page L-3. After you remove the spent case ammunition casings, what should you do next?_____

Use the LOADER PROCEDURE GUIDE for these questions

Write the letter of the right meaning by each symbol.



Meaning

_____

_____

_____

A. More information or a caution or warning.

B. Knob or switch position and light.

C. Question.

On what page are the steps for Before Operations PMCS?_____

On what page is the picture of the Loader's Panel?_____

Turn to page 15. If the tank is operating under arctic conditions, what should you do after removing the hose breakaway socket?_____

Turn to page 19. What should happen when the heater is turned on?

_____

GUNNER

STUDY GUIDE

Use the TM CHECKLIST for these questions

What is the Page Letter Code for Gunner Checks During Normal Operations?_____

On what page are the steps for Gunner's Pre-Fire Operations?_____

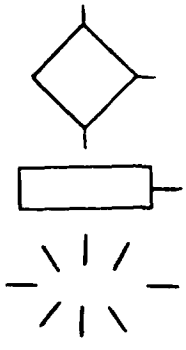
On what page are the steps for emergency service of the air cleaner?_____

Turn to page G-10. After you clear the coax, what should you do next?

_____

Use the GUNNER PROCEDURE GUIDE for these questions

Write the letter of the right meaning by each symbol.



Meaning

_____

_____

_____

A. More information or a caution or warning.

B. Knob or switch position and light.

C. Question.

On what page are the steps for Before Operations PMCS?_____

On what page is the picture for the Gunner's Auxiliary Sight Panel?_____

Turn to page 63. If the tank is operating under arctic conditions, what should you do after removing the hose breakaway socket?_____

Turn to page 68. What should happen when the heater is turned on?

_____

TANK COMMANDER

STUDY GUIDE

Use the TM CHECKLIST for these questions

What is the Page Letter Code for Commander Checks During Normal Operations?_____

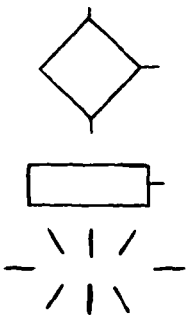
On what page are the steps for Commander's Pre-Fire Operations: Cal .50?_____

On what page are the steps for emergency service of the air cleaner?_____

Turn to page C-3. In post fire operations, after you clear the machinegun, what should you do next?_____

Use the DRIVER PROCEDURE GUIDE for these questions

Write the letter of the right meaning by each symbol.



Meaning

_____

_____

_____

A. More information or a caution or warning.

B. Knob or switch position and light.

C. Question.

On what page are the steps for Before Operations PMCS?_____

On what page is the picture of the Commander's Panel?_____

Turn to page 29. If the tank is operating under arctic conditions, what should you do?_____

Turn to page 31. What should happen when the heater is turned on?_____

_____

JOB AIDS

LOCATE TIME TEST

Scorer: Read the instructions to the soldier. Start timing when you hand him the closed job aid, after you read the instructions. Stop timing when he points to the right task. If he's wrong, keep timing and say, "Wrong." The task is [task title]. "Keep looking." If he doesn't find it within three (3) minutes, stop him and go on to the next task. Have him close the job aid between tasks.

Instructions: "Now we will conduct a test of the three job aids, to see how long it takes to find different tasks in each. I will tell you the name of a task. You are to fine the task in the [job aid]. When you find it, point to it on the page so I know that you have it. Do you have any questions?"..... (Give the job aid to the soldier.)

"Find the [position] task [task title]. Begin."

NAME: _____

CL	GUNNER	PREPARE GUNNER'S STATION FOR OPERATION (G-1)	_____
		PERFORM COMPUTER SELF-TEST (G-2)	_____
		PERFORM TIS CHECKOUT (G-4)	_____
TM	DRIVER	POWER UP HULL SYSTEMS (2-76)	_____
		START ENGINE (2-98)	_____
		SHUT DOWN ENGINE (2-124)	_____
PG	LOADER	INSTALL LOADER'S MACHINEGUN (2)	_____
		POWER UP LOADER'S STATION (4)	_____
		POWER DOWN LOADER'S STATION (6)	_____

Months as GUNNER: _____

Months assigned as Driver: _____ Ever done Driver tasks: _____

Months assigned as Loader: _____ Ever done Loader tasks: _____

Months assigned as TC: _____ Ever done TC tasks: _____

REQUIREMENTS FOR JOB AID TESTING

DRIVER'S STATION

Objective: To measure speed and accuracy of soldiers using three job aids (M1 Tank TM, M1 Tank Driver's Procedure Guide, or M1 Tank Crew Checklist) while performing three Driver tasks: Power Up Hull Systems, Start Engine and Make After Start Checks, and Shut Down Engine and Power Down and Secure Driver's Station.

Equipment Requirements:
a. 1 M1 tank.
b. 1 stopwatch.
c. 1 clipboard.
d. 2 pencils.
e. 1 set job aids.
f. 1 set of scoresheets per soldier.

Personnel Requirements:
a. Trained scorer.

Site Requirements:
a. These tasks will be performed on M1 tanks outdoors.
b. There must be clear area on all sides of tank to prevent injury or damage when the tank is started.
c. Turret must be turned 90°.

STATION SETUP

DRIVER'S STATION

Before Each Test Session:
a. See that tank chock blocks are in place.
b. Have turret turned to side.
c. Lock turret traverse lock.
d. Ensure CREW FIRE and ENGINE FIRE extinguisher handles are seated in mount.
e. Test PANEL LIGHTS with VEHICLE MASTER POWER ON.

Before Each Soldier:
a. Open driver's hatch.
b. Set parking brake.
c. Ensure transmission control is set to N.
d. Ensure steer throttle control is centered.
e. Set TACTICAL IDLE switch in the ON position.
f. Set TANK SELECTOR switch to LEFT FRONT.
g. Open FIRE EXTINGUISHER 2ND SHOT cover (don't trip switch!).
h. Turn domelight knob fully clockwise.
i. Turn PANEL LIGHTS knob fully counterclockwise.
j. Place job aids on front slope of hull.

NOTE: Have soldier do k, l, and m before leaving tank.

k. Close drain valves (down).
l. Set circuit breaker 6 in the hull networks box to OFF.
m. Set circuit breaker 4 in the power distribution box to OFF.

Other:
a. Turn on AUX HYDR PWR every two hours for 15 minutes.

Station Restoration for Power Up Hull Systems:
(as above)

Station Restoration for Start Engine and Make After Start Checks:
a. Set TACTICAL IDLE switch to OFF.
b. Set parking brake.
c. Ensure transmission control is set to N.
d. Ensure steer throttle control is centered.

Station Restoration for Shutdown Engine and Power Down and Secure Driver's Station:
a. Set parking brake.
b. Start engine.
c. Close drain valves.
d. Open driver's hatch.

SCORESHEET

DRIVER'S STATION

POWER UP HULL SYTEMS

Name:_____ SSN:_____ TM PG CL

Soldier's Position: In driver's seat. Tell soldier "The turret traverse is locked. Enter through driver's hatch and adjust the headrest and upper seat back."

Scorer's Position: On front slope of hull.

Instructions: "Let me have your attention. Your first task at this station is to power up the hull systems. You must use the _____. Do you have any questions? . . . [For CL only: "Power up begins at step 1 of Prepare the Driver's Station for Operation."] Start when I say begin. . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Set the TACTICAL IDLE switch to OFF.	___	___	___	___
2. Set the TANK SELECTOR switch to REAR.	___	___	___	___
3. Close the FIRE EXTINGUISHER 2ND SHOT cover.	___	___	___	___
4. Turn domelight control knob counter-clockwise all the way. (Domelight will not light at PM 9.)	___	___	___	___
5. Open cover of hull networks box.	___	___	___	___
*6. Set circuit breaker to ON.	___	___	___	___
7. Open cover of hull power distribution box.	___	___	___	___
*8. Set circuit breaker to ON.	___	___	___	___
NOTE: For CL only -- Say "Turn on VEHICLE MASTER POWER."				
9. Set VEHICLE MASTER POWER switch to ON and release.	___	___	___	___
10. Press and hold PANEL LIGHTS TEST button.	___	___	___	___
11. Release PANEL LIGHTS TEST button.	___	___	___	___
(Not scored: Soldier may press PNL DIM button.)				
12. Turn PANEL LIGHTS knob clockwise. (Panel lights get brighter.)	___	___	___	___
13. Push in and set TANK SELECTOR switch to RIGHT FRONT.	___	___	___	___

	Yes	No	Prompt V	Prompt VP
14. Push in and set TANK SELECTOR switch to LEFT FRONT.	___	___	___	___
*15. Push in and set TANK SELECTOR switch to REAR.	___	___	___	___

NOTE: For CL only -- stop time and say "Stop. Do not do the rest of the task."

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

DRIVER'S STATION

START ENGINE AND MAKE AFTER START CHECKS

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Driver's seat.

Scorer's Position: Front slope of hull.

Instructions: Your next task is to start the engine and make after-start checks. You must use the _____. Do you have any questions? . . . Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Ensure no one is behind tank (ask scorer, say he'd ask TC, say he'd look).	___	___	___	___
NOTE: Make sure no one is behind tank. Tell soldier "Clear."				
2. Ensure TURRET POWER is set to OFF (ask scorer, say he'd ask TC).	___	___	___	___
3. Press in and hold PUSH TO START button for about 1 second, then let go.	___	___	___	___
NOTE: If engine start aborts, stop time, wait until ABORT light goes off, then have soldier try to start engine again. If engine starts, score PM4 Yes. If not, follow malfunction procedures.				
NOTE: TRANSMISSION OIL PRESS LOW light may stay on for less than one minute after engine is started. If soldier tries to troubleshoot, say "There is no malfunction. Continue the task."				
4. Wait until green STARTED light is OFF.	___	___	___	___
5. Set TACTICAL IDLE switch to ON.	___	___	___	___
*6. Set TACTICAL IDLE switch to OFF.	___	___	___	___
7. Inform all personnel inside and outside of tank that brake check is going to be done. (Tell scorer.)	___	___	___	___
NOTE: Make sure area in front is clear. Tell soldier "Clear."				
8. Press and hold service brake pedal.	___	___	___	___
9. Pull PARKING BRAKE RELEASE handle, then push it back.	___	___	___	___
10. Hold service brake pedal and set transmission control to D (tank doesn't creep).	___	___	___	___

		Yes	No	Prompt V	Prompt VP
11.	Twist throttle controls slowly rearward and hold when RPM gage shows 1450-1550 rpm.	___	___	___	___
12.	Let go of throttle controls (forward).	___	___	___	___
13.	Set transmission control to N.	___	___	___	___
*14.	Press parking brake pedal (ratchet noise) then let go.	___	___	___	___
15.	Release service brake pedal.	___	___	___	___
16.	Inform personnel inside and outside tank that brake check is finished. (Tell scorer.)	___	___	___	___
17.	Press and hold service brake pedal.	___	___	___	___
18.	Set transmission control to D.	___	___	___	___
19.	Turn steer control all the way to the right.	___	___	___	___
20.	Turn steer control all the way to the left.	___	___	___	___
21.	Turn steer control back to center position.	___	___	___	___
*22.	Set transmission control to N.	___	___	___	___
23.	Release service brake pedal.	___	___	___	___

Time: _____

Comments: _____

_____

_____

_____

SCORESHEET

DRIVER'S STATION

SHUT DOWN ENGINE AND POWER DOWN AND SECURE DRIVER'S STATION

Name:_____ **SSN:**_____ **TM PG CL**

Soldier's Position: In driver's seat.

Scorer's Position: On front slope.

Instructions: Your next task is to shut down the engine and power down and secure the station. You must use the _____. Do you have any questions? . . . Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Pull out and set ENGINE SHUTOFF switch down to SHUTOFF.	___	___	___	___
2. Move both drain valve handles up to open.	___	___	___	___
NOTE: Wait 5 seconds then say "Turn VEHICLE MASTER POWER off." Soldier should be scored NO if he does PM3 before you tell him to.				
3. Set VEHICLE MASTER POWER switch to OFF.	___	___	___	___
4. Turn and hold latch to release from stop.	___	___	___	___
5. Squeeze and turn hatch handcrank about one turn to move latch past stop.	___	___	___	___
6. Let go of latch.	___	___	___	___
7. Turn handcrank until hatch is over opening.	___	___	___	___
8. Reach over right shoulder with right hand and grasp hatch lifting handle.	___	___	___	___
9. Press and hold button in handle.	___	___	___	___
10. Pull down handle until it snaps into clip, then let go (hatch drops into place).	___	___	___	___

NOTE: For CL only -- Stop time and have soldier open hatch and exit tank.

Time:_____

Comments:_____

_____

_____

_____

REQUIREMENTS FOR JOB AID TESTING

LOADER'S STATION

Objective: To measure speed and accuracy of soldiers using three job aids (M1 Tank TM, M1 Tank Loader's Procedure Guide, or M1 Tank Crew Checklist) while performing three Loader tasks: Install Loader's Machinegun, Power Up Loader's Station, and Power Down Loader's Station.

Equipment Requirements:

a. 1 M1 tank.
b. 1 loader's machinegun.
c. 1 dummy main gun round.
d. 1 extractor tool.
e. 1 wooden block (2 ft. long, 4 x 4 inches).
f. 1 two piece antenna (AS1729).
g. 1 stopwatch.
h. 1 clipboard.
i. 2 pencils.
j. 1 set of job aids.
k. 1 set of scoresheets per soldier.

Personnel Requirements:

a. Trained scorer.

Site Requirements:

a. These tasks will be performed on an M1 tank.
b. Turret must be positioned so hull ammo door is visible.

STATION SETUP

LOADER'S STATION

Before Each Test Session:
a. Erect crosswind sensor.
b. Set GUN SELECT switch on gunner's panel to TRIGGER/SAFE.
c. Unlock turret traverse lock.
d. Ensure hull ammo door is visible.
e. Ensure spent case ejection guard is forward.

Before Each Soldier:
a. Loosen skate lock on loader's machinegun mount.
b. Loosen azimuth lock on loader's machinegun mount.
c. Unlock elevation lock pin on loader's machinegun mount.
d. Ensure loader's machinegun mounting pins are locked into the mount.
e. Place loader's machinegun on turret next to mount.
f. Set TURRET POWER switch on TC panel to ON (TURRET POWER light on).
g. Set AUX HYDR PWR on TC panel to ON.
h. Set GUN/TURRET DRIVE switch to POWERED.
i. Level gun tube.
j. Load dummy round.
k. Place knee guard in stowed position.
l. Place antenna in loader's oddment box.
m. Place wooden block in TC's canteen box.
n. Place extractor tool under gunner's seat.
o. Set MAIN PWR switch on amplifier to OFF.
p. Set POWER CKT BKR switch to OFF.
q. Set INT ACCENT switch to OFF.
r. Set RADIO TRANS switch to LISTENING SILENCE.
s. Connect loader's CVC cables to intercom box.
t. Turn domelight on if needed.
u. Put job aids in TC station.

Other:
a. Set TURRET POWER to OFF between soldiers.

Station Restoration for Install Loader's Machinegun:
(as above)

Station Restoration for Power Up Loader's Station:
a. Set GUN/TURRET DRIVE to POWERED.
b. Place antenna in loader's oddment box.
c. Set MAIN PWR switch on amplifier to OFF.
d. Set POWER CKT BKR switch to OFF.
e. Set INT ACCENT switch to OFF.
f. Set RADIO TRANS switch to LISTENING SILENCE.

Station Restoration for Power Down Loader's Station:
a. Unlock turret traverse lock.
b. Load dummy round.
c. Set MAIN PWR switch on amplifier to ON.
d. Connect loader's CVC cables to intercom box.

SCORESHEET

LOADER'S STATION

INSTALL LOADER'S MACHINEGUN

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Standing in loader's hatch.

Scorer's Position: Standing in TC hatch.

Instructions: "Let me have your attention. Your first task at this station is to install the loader's machinegun. You must use the _____. Do you have any questions? . . . [For CL only: "Install Loader's Machinegun is at step 3 of Prepare Loader's Station for Operation."] Start when I say begin. . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Turn skate lock clockwise.	___	___	___	___
2. Turn azimuth lock clockwise.	___	___	___	___
3. Pull out on ring on elevation lock pin and rotate one quarter turn and release.	___	___	___	___
4. Remove 2 mounting pins.	___	___	___	___
5. Put machinegun into mount.	___	___	___	___
6. Insert mounting pins (rings flush with mount).	___	___	___	___

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

LOADER'S STATION

POWER UP LOADER'S STATION

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Seated in loader's seat.

Scorer's Position: Seated in TC seat.

Instructions: "Your next task at this station is to Power Up the Loader's Station. You must use the _____. Do you have any questions? . . . [For CL only: "Power Up the Loader's Station begins at step 10 of Prepare Loader's Station for Operation."] Start when I say begin. . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
*1. Set GUN/TURRET DRIVE switch to MANUAL.	___	___	___	___
2. Screw 2 antenna pieces together.	___	___	___	___
3. Screw antenna to mount base.	___	___	___	___
*4. Set MAIN PWR switch on amplifier to NORM.	___	___	___	___
5. Set POWER CKT BKR switch to ON.	___	___	___	___
6. Set INT ACCENT switch to ON.	___	___	___	___
7. Set RADIO TRANS switch to CDR + CREW.	___	___	___	___

NOTE: For CL only -- Say "Stop. Do not do the rest of the task."

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

LOADER'S STATION

POWER DOWN LOADER'S STATION

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Seated in Loader's seat.

Scorer's Position: Seated in TC seat.

Instructions: "Your third task at this station is to Power Down the Loader's Station. You must use the _____. Do you have any questions? . . . Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Lock turret travere lock.	___	___	___	___
2. Set GUN/TURRET DRIVE switch to EL UNCPL.	___	___	___	___
3. Pull breech handle to rear until it locks.	___	___	___	___
4. Return handle to upright locked position.	___	___	___	___
NOTE: PM 4 must be done before test continues!				
5. Remove round from chamber.	___	___	___	___
SAY: "Stow round in ready ammo rack."				
6. Place round in ready ammo rack.	___	___	___	___
7. Check main gun tube (look into tube).	___	___	___	___
8. Trip right extractor (use block or extractor).	___	___	___	___
9. Trip left extractor (use block or extractor).	___	___	___	___
10. Set GUN/TURRET DRIVE switch to MANUAL.	___	___	___	___
11. Set amplifier MAIN PWR switch to OFF.	___	___	___	___
12. Disconnect CVC from intercom box.	___	___	___	___

NOTE: For CL only -- Say "Stop. Do not do the rest of the task."

Time:_____

Comments:_____

_____

_____

_____

REQUIREMENTS FOR JOB AID TESTING

GUNNER'S STATION

Objective: To measure the speed and accuracy of soldiers using three aids (M1 Tank TM, M1 Tank Gunner's Procedure Guide, or M1 Tank Crew Checklist) while performing three Gunner tasks: Power Up Gunner's Station, Perform Computer Self-Test, and Perform TIS Checkout.

Equipment Requirements:
a. 1 M1 tank.
b. 1 stopwatch.
c. 1 clipboard.
d. 2 pencils.
e. 1 set of job aids.
f. 1 set of scoresheets per soldier.
g. Identifiable object at least 1000 meters from tank.

Personnel Requirements:
a. Trained scorer.

Site Requirements:
a. These tasks will be performed on M1 tank outdoors.
b. Sufficient space is required for free and safe turret movement.

STATION SETUP

GUNNER'S STATION

Before Each Test Session:

a. Perform panel lights test.
b. Null out turret drift.
c. Perform computer lights test and self-test.
d. Open DAY ballistic door.
e. Perform TIS checkout.
f. If gun is over rear deck, elevate at least 5°.

Before Each Soldier:

a. Lock elevation travel lock.
b. Lock turret traversing lock.
c. Set FIRE CONTROL MODE switch to NORMAL.
d. Set GUN/TURRET DRIVE switch on loader's panel to MANUAL.
e. Set FLTR/CLEAR/SHTR switch to CLEAR.
f. Set POLARITY switch to BLACK HOT.
g. Set THERMAL MAGNIFICATION lever to 10X.
h. Set UNIT TEST PATTERN switch to OFF.
i. Close THERMAL ballistic door.
j. Set TURRET POWER to ON.
k. Set AUX HYDR PWR to ON.
l. Cancel range input and latch CCP door.
m. Press TC's MANUAL RANGE BATTLE SGT button.
n. Turn adjustment knob for GPS and TIS panel lights counterclockwise until it stops.
o. Set circuit breaker 25 (LRF) to OFF in turret networks box.
p. Place job aids in commander's .50 caliber ammunition stowage compartment.
q. Point out target to soldier before he enters the tank.

Other:

a. Have TC run tank every 2 hours to maintain battery charge (monitor TC's LOW BAT CHG Light).
b. Set TURRET POWER to OFF between soldiers and at the end of each test session, after TIS READY goes OFF.

Station Restoration for Power Up Gunner's Station:
(as above)

Station Restoration for Perform Computer Self-Test:

a. Set FIRE CONTROL MODE switch to MANUAL.
b. Latch cover on CCP.

Station Restoration for Perform TIS checkout.

a. Set FLTR/CLEAR/SHTR switch to CLEAR.
b. Set POLARITY switch to BLACK HOT.
c. Set THERMAL MAGNIFICATION lever to 10X.
d. Set UNIT TEST PATTERN switch to OFF.
e. Close THERMAL ballistic door.
f. Cancel range input and latch CCP cover.
g. Press MANUAL RANGE BATTLE SGT button.

SCORESHEET

GUNNER'S STATION

POWER UP GUNNER'S STATION

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Gunner's seat.

Scorer's Position: Commander's seat.

Instructions to Soldiers: "Let me have your attention. Your first task at this station is to Power Up the Gunner's Station. You must use the _____. The TIS will be used. Do you have any questions? . . . [For CL only: "Power Up begins at step 7 of Prepare the Gunner's Station for Operation. Do not install the coax."] Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Push PANEL LIGHTS TEST pushbutton.	___	___	___	___
2. Turn PANEL LIGHTS knob.	___	___	___	___
3. Open CCP cover.	___	___	___	___
4. Set CCP power to ON.	___	___	___	___
5. Push TEST pushbutton on CCP.	___	___	___	___
6. Latch cover on CCP.	___	___	___	___
*7. Set THERMAL MODE switch to STBY (noise).	___	___	___	___
*8. Unlock elevation travel lock.	___	___	___	___
*9. Ensure turret traverse lock is unlocked. (Look, ask Scorer, say he would ask loader, or unlock.)	___	___	___	___
*10. Set FIRE CONTROL MODE switch to MANUAL.	___	___	___	___
*11. Ensure GUN/TURRET DRIVE switch is set to POWERED. (Look, ask Scorer, say he would ask loader, or set switch.)	___	___	___	___

NOTE: For CL only -- Stop time and say "Stop. Do not do the rest of the task."

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

GUNNER'S STATION

PERFORM COMPUTER SELF-TEST

Name:_____ SSN:_____ TM PG CL

Soldier's Position: Gunner's seat.

Scorer's Position: Commander's seat.

Instructions to Soldier: "Your next task at this station is to perform a Computer Self-Test. You must use the _____. Do you have any questions? . . . [For CL only: "Perform Computer Self-Test begins at step 23 of Prepare Gunner's Station for Operation."] Start when I say begin. . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Set FIRE CONTROL MODE switch to NORMAL.	___	___	___	___
2. Look into GPS with palm switches squeezed.	___	___	___	___
3. Open CCP cover.	___	___	___	___
4. Set CCP POWER switch ON.	___	___	___	___
5. Wait 90 seconds.	___	___	___	___
6. Squeeze and hold palm switch on power control handle.	___	___	___	___
7. Push and release TEST button.	___	___	___	___
8. When NO GO lights up and 8 appears in window, push and release flashing RANGE button.	___	___	___	___
9. Push and release ENTER key.	___	___	___	___
NOTE: When FAIL appears in window, say "Do not troubleshoot."				
10. Release palm switches.	___	___	___	___
*11. Latch CCP door.	___	___	___	___

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

GUNNER'S STATION

PERFORM TIS CHECKOUT

Name:_____ **SSN:**_____ TM PG CL

Soldier's Position: Gunner's seat.

Scorer's Position: Commander's seat.

NOTE: Do not begin until THERMAL MODE READY light is lit.

Instructions to Soldier: "Your third task at this station is to perform a TIS Checkout. You must use the _____. Use the target that was shown to you before entering the Gunner's station. Do you have any questions? . . . [For CL only: "TIS Checkout begins at step 25 of Prepare Gunner's Station for Operation."] Start when I say begin. . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Set FLTR/CLEAR/SHTR switch to SHTR.	___	___	___	___
2. Set POLARITY switch to WHITE HOT.	___	___	___	___
3. Set THERMAL MAGNIFICATION lever to 3X.	___	___	___	___
4. Set UNIT TEST PATTERN switch to PCU.	___	___	___	___
NOTE: FAULT LIGHT may come on for 5 seconds with each UNIT TEST PATTERN SETTING. Tell soldier to continue.				
5. Look into GPS.	___	___	___	___
6. Set UNIT TEST PATTERN switch to ICU.	___	___	___	___
7. Look into GPS.	___	___	___	___
8. Set UNIT TEST PATTERN switch to EU.	___	___	___	___
9. Set THERMAL MODE switch to ON.	___	___	___	___
10. Look into GPS.	___	___	___	___
11. Set THERMAL MAGNIFICATION lever to 10X.	___	___	___	___
12. Look into GPS.	___	___	___	___
13. Set UNIT TEST PATTERN switch to TRU.	___	___	___	___
14. Look into GPS.	___	___	___	___
15. Turn CONTRAST knob while looking in GPS.	___	___	___	___
16. Turn SENSITIVITY knob while looking in GPS.	___	___	___	___

	Yes	No	Prompt V	Prompt VP
17. Turn RETICLE knobs while looking in GPS.	___	___	___	___
18. Set POLARITY switch to BLACK HOT.	___	___	___	___
19. Look into GPS.	___	___	___	___
20. Set POLARITY switch to WHITE HOT.	___	___	___	___
21. Look into GPS.	___	___	___	___
22. Set UNIT TEST PATTERN switch to OFF.	___	___	___	___
23. Open THERMAL ballistic door.	___	___	___	___
24. Look into GPS.	___	___	___	___
(Not scored: soldier may adjust TIS image.)				
NOTE: Make sure no one is in the way of the gun.				
25. Lay gun on target. (Scorer: check the lay of the gun by observing it through the Commander's GPS extension.)	___	___	___	___
26. Open CCP cover.	___	___	___	___
27. Set CCP POWER switch to ON.	___	___	___	___
28. Press RANGE key.	___	___	___	___
29. Press keys 2, 6, 8, and 0.	___	___	___	___
30. Press ENTER key.	___	___	___	___
31. Turn SYMBOL knob clockwise while looking in GPS.	___	___	___	___
32. Turn SYMBOLS knob counterclockwise while looking in GPS.	___	___	___	___
33. Set THERMAL MAGNIFICATION LOCK lever to 3X.	___	___	___	___
NOTE: Be sure UNIT TEST PATTERN is OFF before PM 34.				
NOTE: Say "The TIS will not be used any more."				
34. Set THERMAL MODE switch to OFF.	___	___	___	___
35. Close THERMAL ballistic door.	___	___	___	___
36. Set FLTR/CLEAR/SHTR switch to CLEAR.	___	___	___	___
(Not socred: Soldier may cancel range input.)	Time:_____			

Comments:_____

REQUIREMENTS FOR JOB AID TESTING

TANK COMMANDER'S STATION

Objective: To measure speed and accuracy of soldiers using three job aids (M1 Tank TM, M1 Tank Tank Commander's Procedure Guide, or M1 Tank Crew Checklist) while performing three tank commander tasks: Install Commander's Weapon, Power Up Commander's Station and Turret, and Power Down and Secure Station.

Equipment Requirements:
a. 1 M1 tank.
b. 1 Caliber .50 M2 machinegun.
c. 1 adjustable wrench.
d. 1 stopwatch.
e. 1 clipboard.
f. 2 pencils.
g. 1 set job aids.
g. 1 set scoresheets per soldier.

Personnel Requirements:
a. Trained scorer.

Site Requirements:
a. These tasks will be performed on an M1 tank.

NOTE: The Tank Commander's tests may be set up and conducted at the Loader's Station or Gunner's Station.

STATION SETUP

TANK COMMANDER'S STATION

Before Each Test Session:
a. Place the GUN/TURRET DRIVE switch on loader's panel in MANUAL position.
b. Place the spent case ejection guard forward in safe position.
c. Set timing on commander's weapon.

Before Each Soldier:
a. Place TC hatch in full open position.
b. Place safety on commander's weapon station elevation crank to FIRE.
c. Turn CWS MANUAL/POWER lever to POWER.
d. Adjust equilibrator too tight.
e. Un-level commander's weapon mount.
f. Place mounting pins in mount.
g. Place machinegun on turret, barrel removed.
h. Place wrench in tool bag.
i. Connect CVC cord to intercom box.
j. Turn PANEL LIGHTS knob fully counterclockwise.
k. Turn domelight seitch fully clockwise.
l. Turn VEHICLE MASTER POWER switch OFF.
m. Unlock elevation travel lock and turret traverse lock.
n. Place job aids on top of turret.

Station Restoration for Install Commander's Weapon:
(as above)

Station Restoration for Power Up Commander's Station and Turret:
a. Turn VEHICLE MASTER POWER switch OFF.
b. Turn PANEL LIGHTS knob fully counterclockwise.

Station Restoration for Power Down and Secure Station:
a. Mount machinegun.
b. Connect CVC cord to intercom box.
c. Turn domelight switch all the way clockwise.
d. Unlock elevation travel lock and turret traverse lock.
e. Turn TURRET POWER switch ON.
f. Turn AUX HYDR PWR switch ON.

SCORESHEET

TANK COMMANDER'S STATION

INSTALL COMMANDER'S WEAPON

Name:_____ SSN:_____ TM PG CL

Soldier's Position: On turret.

Scorer's Position: On turret.

Instructions: "Let me have your attention. Your first task at this station is to install the commander's weapon. You must use the _____. Do not set headspace and timing. Do you have any questions?". . . [For CL only: "Install Commander's Weapon is at step 1 of Prepare Commander's Station for Operation."] Start when I say begin. . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Check that weapon is clear.	___	___	___	___
2. Set safety above CWS elevation crank to SAFE.	___	___	___	___
3. Level commander's machinegun mount using elevation crank.	___	___	___	___
4. Remove 2 round mounting pins from the mount.	___	___	___	___
5. Remove rear flat mounting pin from mount and insert pin in stowage slot.	___	___	___	___
6. Put machinegun receiver in mount.	___	___	___	___
7. Ensure trigger is behind butterfly.	___	___	___	___
8. Insert 2 mounting pins.	___	___	___	___
9. Pull and hold charging handle to the rear (barrel locking spring lug visible in 3/8 inch hole).	___	___	___	___
10. Screw barrel all the way into barrel extension.	___	___	___	___
11. Unscrew barrel two notches (clicks).	___	___	___	___

			Prompt	
	Yes	No	V	VP
12. Release charging handle, allowing bolt to go forward.	___	___	___	___
13. Elevate and depress weapon (will bind).	___	___	___	___
14. Depress weapon to maximum depression.	___	___	___	___
15. Loosen equilibrator locknut on equilibrator adjusting bolt.	___	___	___	___
16. Turn equilibrator adjusting bolt.	___	___	___	___
17. Elevate and depress weapon.	___	___	___	___
18. Turn locknut clockwise until locknut is fully seated against mount.	___	___	___	___
NOTE: Say "Do not set headspace and timing."				
19. Set machinegun safety to F.	___	___	___	___
20. Pull charging handle down and to the rear, then let go.	___	___	___	___
21. Set safety switch on CWS elevation crank to FIRE.	___	___	___	___
22. Pull down on CWS elevation crank knob to test machinegun firing mechanism.	___	___	___	___
*23. Set CWS safety switch to SAFE.	___	___	___	___
*24. Set machinegun safety to S.	___	___	___	___

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

TANK COMMANDER'S STATION

POWER UP COMMANDER'S STATION AND TURRET

Name:_____ SSN:_____ TM PG CL

Soldier's Position: In TC seat.

Scorer's Position: In Loader's station.

Instructions: Your next task is to power up the commander's station and turret. You must use the _____. Turret equipment will be used, and the engine will not be started. Do you have any questions?". . . [For CL only: "Power up begins at step 3 of Prepare the Commander's Station for Operation. The crew has reported 'Ready.'"] Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
*1. Set TURRET POWER switch to ON (VEHICLE MASTER POWER light and TURRET POWER LIGHT come on).	___	___	___	___
*2. Set AUX HYDR PWR switch to ON (AUX HYDR PWR light comes on).	___	___	___	___
3. Press PANEL LIGHTS test button.	___	___	___	___
4. Check lights on loader's panels with PANEL LIGHTS test button pressed. (Look, say he'd ask loader, ask scorer.)	___	___	___	___
5. Turn PANEL LIGHTS knob clockwise. (VEHICLE MASTER POWER LIGHT gets brighter.)	___	___	___	___

NOTE: For CL only say: "Stop. Do not do the rest of the task."

Time:_____

Comments:_____

_____

_____

_____

SCORESHEET

TANK COMMANDER'S STATION

POWER DOWN AND SECURE STATION

Name: _____ SSN: _____ TM PG CL

Soldier's Position: In TC seat.

Scorer's Position: In Loader's station.

Instructions: "Your next task is to power down and secure the commander's station. You must use the _____. If you need assistance, you may ask me. Do you have any questions?. . . Start when I say begin . . . Begin." Start time.

Performance Measures:	Yes	No	Prompt V	Prompt VP
1. Unlatch and open receiver cover.	___	___	___	___
2. Hold charging handle back and look in chamber.	___	___	___	___
3. Let charging handle go (pull trigger and ease bolt forward).	___	___	___	___
4. Set butterfly trigger safety to F.	___	___	___	___
5. Close and latch receiver cover.	___	___	___	___
6. Press butterfly trigger to release firing pin.	___	___	___	___
7. Set butterfly trigger safety to S.	___	___	___	___
8. Pull charging handle back and hold (barrel locking spring lug visible in 3/8 inch hole).	___	___	___	___
9. Unscrew and remove barrel from barrel extension.	___	___	___	___
10. Release charging handle and allow bolt to go forward.	___	___	___	___

			Prompt	
	Yes	No	V	VP
12. Remove 2 mounting pins.	___	___	___	___
13. Lift receiver from machinegun mount. (Set on turret.)	___	___	___	___
14. Insert mounting pins back into holes in mount.	___	___	___	___
15. Lock elevation travel lock (ask, say he'd ask gunner).	___	___	___	___
16. Lock turret traverse lock (ask, say he'd ask loader).	___	___	___	___
17. Disconnect CVC cord from intercom box.	___	___	___	___
18. Close commander's hatch.	___	___	___	___
19. Set and hold VEHICLE MASTER POWER switch to OFF (light goes out).	___	___	___	___

Time: _____

Comments: _____

_____

_____

_____

APPENDIX D

Analysis of Variance Summary Tables for Performance Accuracy (Percent Performance Measures Passed)

Table D.1
ANOVA Summary Table for
Performance Accuracy (Percent Performance Measures Passed)
on Driver, Loader, and Gunner Tasks
with Location, Group, Job Aid, Crew Position,
and Task Within Crew Position as Factors

Source	df	MS	F
Between Subjects	53		
Location	1	6568.00	9.52*
Group	2	1100.27	1.91
Location x Group	2	279.68	<1
Subjects/Location x Group	48	576.80	<1
Within Subjects	432		
Job Aid	2	4484.35	21.08**
Crew Position	2	22172.45	104.24**
Task/Position	6	10135.82	47.65**
Aid x Position	4	514.50	2.42*
(Aid x Task/Position)[1]	10	665.88	3.13**
Aid x Location	2	1281.65	6.02**
Position x Location	2	651.35	3.06*
Task/Position x Location	6	1296.68	6.10**
Aid x Position x Location	4	531.88	2.50*
(Aid x Task/Position x Location)[2]	10	237.34	1.12
Error	384	212.71	

[1] Partially confounded with Group
[2] Partially confounded with Location x Group
* $p < .05$
** $p < .01$

Table D.2
ANOVA Summary Table for
Performance Accuracy (Percent Performance Measures Passed)
on Tank Commander Tasks With Crewmember,
Group, Job Aid, and Task as Factors

Source	df	MS	F
Between Subjects	17		
Crewmember	1	2268.52	7.91**
Group	2	291.73	1.02
Crewmember x Group	2	723.59	2.52
Subjects/Crewmember x Group	12	286.70	
Within Subjects	36		
Job Aid	2	2026.87	2.94
Task	2	2971.92	4.31*
(Aid x Task)[1]	2	47.34	< 1
Aid x Crewmember	2	146.58	< 1
Task x Crewmember	2	46.20	< 1
(Aid x Task x Crewmember)[2]	2	41.65	< 1
Error	24		

[1] Partially confounded with Group
[2] Partially confounded with Crewmember x Group
* $p < .05$
** $p < .01$

APPENDIX E

Analysis of Variance Summary Tables for Performance Accuracy (GO/NO GO)

Table E.1
ANOVA Summary Table for
Performance Accuracy (GO/NO GO) on
Driver, Loader, and Gunner Tasks
With Location, Group, Job Aid, Crew Position,
and Task Within Crew Position as Factors

Source	df	MS	F
Between Subjects	53		
Location	1	.00	0.00
Group	2	.31	1.94
Location x Group	2	.04	< 1
Subjects/Location x Group	48	.16	
Within Subjects	432		
Job Aid	2	2.31	17.04**
Crew Position	2	6.28	46.31**
Task/Position	6	3.33	24.54**
Aid x Position	4	.10	< 1
(Aid x Task/Position)[1]	10	.34	2.49**
Aid x Location	2	.24	1.77
Position x Location	2	.10	< 1
Task/Position x Location	6	.17	1.26
Aid x Position x Location	4	.02	< 1
(Aid x Task/Position x Location)[2]	10	.34	2.54
Error	384		

[1] Partially confounded with Group
[2] Partially confounded with Location x Group
** $p < .01$

Table E.2
ANOVA Summary Table for
Performance Accuracy (GO/NO GO)
on Tank Commander Tasks
With Crewmember, Group, Job Aid, and Task as Factors

Source	df	MS	F
Between Subjects	17		
Crewmember	1	1.18	16.00**
Group	2	.21	2.88
Crewmember x Group	2	.16	2.12
Subjects/Crewmember x Group	12	.07	
Within Subjects	36		
Job Aid	2	.30	6.40**
Task	2	.69	15.80**
(Aid x Task)[1]	2	.05	1.00
Aid x Crewmember	2	.07	1.60
Task x Crewmember	2	.35	7.60**
(Aid x Task x Crewmember)[2]	2	.32	7.00**
Error	24	.05	

[1] Partially confounded with Group
[2] Partially confounded with Crewmember x Group
** $p < .01$